

UNITED STATES DISTRICT COURT
DISTRICT OF MONTANA
MISSOULA DIVISION

PAUL PRICE, JOHN PREBIL and MARGERY
PREBIL, on behalf of themselves and all others
similarly situated,

Plaintiffs,

vs.

W.R. GRACE & COMPANY (a Delaware
corporation); W.R. GRACE & COMPANY-CONN
(a Connecticut corporation); W.R. GRACE & CO.,
a/k/a GRACE, an association of business entities;
SEALED AIR CORPORATION (a Delaware
corporation),

Defendants.

No. CV 00-71-M-DWM

AFFIDAVIT OF HENRY A. ANDERSON,
M.D. IN SUPPORT OF PLAINTIFFS'
APPLICATION FOR PRELIMINARY
INJUNCTION AND EMERGENCY
NOTICE TO CLASS MEMBERS



STATE OF WISCONSIN)

COUNTY OF DAKE)

2 HENRY A. ANDERSON, M.D., being duly sworn, deposes and says:

3 1. I am a physician and epidemiologist, and I am currently Chief, Section of
4 Environmental and Chronic Disease Epidemiology with the Wisconsin Division of Health in
5 Madison, Wisconsin. I am also an Adjunct Associate Professor with the University of Wisconsin,
6 with appointments in the Department of Preventive Medicine with the University of Wisconsin
7 Medical School and an appointment with the Institute for Environmental Studies. I presently hold
8 the position of State School Asbestos Coordinator for the state of Wisconsin.
9

10 2. In 1968, I graduated from Stanford University with a B.A. Degree and I received my
11 M.D. Degree from the University of Wisconsin Medical School in Madison in 1972. After
12 completing a one-year straight medical internship in the Department of Medicine, Montefiore
13 Hospital and Medical Center, Bronx, New York, I became a resident in occupational medicine at the
14 Environmental Sciences Laboratory, Mt. Sinai School of Medicine in New York City. After I
15 completed my residency in 1976, I remained at the Mt. Sinai School of Medicine until 1980, where
16 I participated in asbestos-related clinical research. Under the direction of Dr. Irving J. Selikoff,
17 numerous epidemiological studies on the health effects of asbestos exposure were undertaken at the
18 time I was present at the Mt. Sinai School of Medicine. Before leaving the Mt. Sinai School of
19 Medicine as Assistant Professor of Community Medicine in June 1980, I examined over eight
20 hundred persons who were suspected to have asbestos-associated diseases and reviewed the chest
21 x-rays of several thousand others. In order to better facilitate my participation in clinical studies of
22 asbestos workers, I became a "B" reader for the interpretation of x-rays for pneumoconiosis.

23 3. During my tenure with the Environmental Sciences Laboratory at the Mt. Sinai
24 School of Medicine, I developed a particular interest in the study of asbestos-related disease among
25 family members of asbestos workers. In the early 1970's, I initiated, and became the principal
26 investigator of a study of family members of asbestos factory workers in Patterson, New Jersey who
worked in that facility from 1941 to 1945. There were two purposes of the study. The first was to

see whether or not the family members had the stigmata of asbestosis and the second was to

4. The study found that, of those family members who were examined, thirty-five percent of them demonstrated asbestos-associated radiographic abnormalities. Furthermore, of the family members of persons who worked at the asbestos facility between 1941 and 1945, three of these family members died of mesothelioma, a virulent cancer of the pleura and peritoneum that is caused by asbestos. The study concluded that family members of asbestos workers, who would have only been exposed indirectly to asbestos, were at a greatly increased risk for the development of asbestos-associated diseases. These family members contracted disease not by occupational exposure to asbestos, but as a result of the result of the reentrainment of settled dust, either from the workers who came home with dust on their clothing, or from settled dust on household furnishings, including carpeting, sofas and chairs. The study demonstrated that low-level exposures to asbestos, such as the exposure one would have to a worker's clothes, can also cause mesothelioma. This study engendered several published articles authored by me on the subject of asbestos-associated diseases among family members, and these articles are listed on my curriculum vitae which is appended to this affidavit (See attachment A). These follow-up studies show that asbestos exposure in the household places family members at risk for mesothelioma and lung cancer.

5. I was the principal investigator and author of a published epidemiological study involving asbestos-related cancer deaths of Wisconsin state employees. In this study, we reviewed the death certificates of state employees and identified those employees who died of mesothelioma, a form of cancer of the pleura. Mesothelioma is a marker disease, which means that asbestos exposure is the only known cause. The study identified a high incidence of mesothelioma among state workers, whose only known exposure to asbestos was working in buildings with asbestos-containing materials.

6. Along with Dr. Ruth Lillis, I participated in the investigation of asbestos-associated diseases among building maintenance workers. This study found a significant increase in asbestosis among these persons, and the study also reported mesotheliomas among these workers. I am familiar

with other published studies on the incidence of asbestos-associated diseases among building

studies concluded that exposure to asbestos in public schools caused x-ray changes of asbestosis in maintenance and custodial workers. I find these studies to be reliable and to contain information useful in the formation of my opinions on the dangers from low level exposures to asbestos.

7. As a physician and epidemiologist who has been personally involved in research of asbestos-associated diseases, I have come to the following opinions regarding asbestos exposure in homes. These opinions are expressed to a reasonable degree of medical certainty:

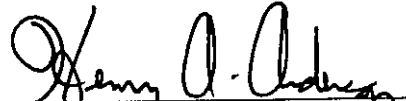
- (a) Inhalation of all types of asbestos, including tremolite, actinolite and anthophyllite asbestos is capable of causing a number of serious and deadly diseases, including asbestosis, lung cancer and mesothelioma.
- (b) These diseases involve a latent process, meaning that symptoms or disease will not be manifest at the time of exposure, but rather after a considerable period of time has passed. In the case of mesothelioma and lung cancer, the latency period is approximately 15-40 years. Furthermore, in the case of mesothelioma, once the disease is diagnosed there is no known cure and the treatment options are limited.
- (c) Any exposure to asbestos adds to the risk of developing asbestos disease. There is no known level of exposure to asbestos below which it can be said with scientific certainty that no risk of developing asbestos disease exists.
- (d) Friable asbestos in homes can present a hazard to homeowners and contractors because disturbance of the material during ordinary activities, such as remodeling, can result in asbestos fibers becoming airborne. Once airborne, asbestos fibers can be inhaled by persons in the home. Fibers not inhaled will eventually settle and contaminate surfaces.
- (e) When asbestos in settled dust is disturbed, it is reentrained into the air and may remain suspended for extended periods of time, resulting in additional exposure. Settled dust reentrainment is an important avenue of exposure for individuals who would not otherwise be exposed to asbestos.
- (f) Asbestos fibers are invisible to the naked eye and can only be identified through use of sophisticated microscopic equipment by highly trained professionals.
- (g) I have reviewed the results W.R. Grace's testing of its Zonolite Attic Insulation during installation, as well as the results of air and dust testing conducted by Fulcrum Environmental and Materials Analytical Services in homes with Zonolite Attic Insulation. In my

opinion, the results show that disturbance of asbestos-contaminated Zonolite Attic Insulation presents a significant hazard potential to

- 2 (h) The hazard of these exposures is aggravated and worsened when the
3 release or disturbance occurs in an enclosed space such as an attic.
- 4 (i) Routine home maintenance, repairs and remodeling in and around
5 asbestos-contaminated insulation should only be done by
6 professionals trained in the use of personal protective equipment such
7 as respirators and other safety techniques pertaining to isolation of the
8 disturbance and preventing release to living spaces.
- 9 (j) In order to safeguard public health, I believe it is essential that
10 homeowners with Zonolite Attic Insulation be warned about the
11 presence of asbestos in this product, be advised not to disturb the
12 material, and be instructed on the precautions necessary to avoid
13 exposure and contamination when conducting activities that disturb
14 the material. Ultimately an abatement performed by professionals
15 may be necessary to prevent hazardous exposures.

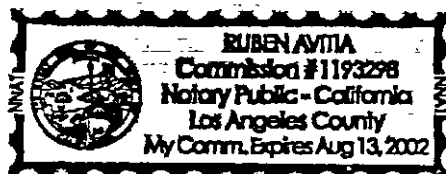
11 Further Affiant sayeth not.

12 Dated this 20 day of July, 2000.


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14 
HENRY A. ANDERSON, MD

15 State of California
16 County of Los Angeles

17 SUBSCRIBED AND SWORN to before me this 20th day of July, 2000.



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Notary Public in and for the State of California
Residing at Los Angeles, CA
My commission expires: Aug. 13, 2002

HENRY A. ANDERSON, M.D.

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Date of birth: December 10, 1945
Wisconsin MD Lisc# 18539

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PROFESSIONAL HISTORY

10/91 - current	Chief Medical Officer for Occupational & Environmental Health Wisconsin Division of Health, Madison.
6/80 - current	State Epidemiologist for Occupational and Environmental Disease Wisconsin Division of Health, Madison.
6/89 - current	Adjunct Professor, Institute for Environmental Studies University of Wisconsin, Madison.
6/89 - current	Adjunct Professor of Preventive Medicine University of Wisconsin Medical School, Madison.
6/80 - current	Lecturer, Department of Community Medicine Mount Sinai School of Medicine, New York
6/80 - 10/91	Chief, Section of Environmental and Chronic Disease Epidemiology Wisconsin Division of Health, Madison.
6/85 - 6/89	Adjunct Associate Professor, Institute for Environmental Studies University of Wisconsin, Madison.
6/85 - 6/89	Adjunct Associate Professor of Preventive Medicine University of Wisconsin Medical School, Madison.
6/80 - 6/85	Adjunct Assistant Professor of Preventive Medicine University of Wisconsin Medical School, Madison.
1/78 - 6/80	Assistant Professor of Community Medicine Environmental Sciences Laboratory Mount Sinai School of Medicine, New York

EXHIBIT

A
Anderson

Mount Sinai School of Medicine, New York

1/77 - 1/78	Instructor, Department of Community Medicine Mount Sinai School of Medicine, New York
1/76 - 1/77	Assistant, Department of Community Medicine Mount Sinai School of Medicine, New York
1/76 - 1/77	Research Fellow, Department of Medicine Mount Sinai School of Medicine, New York
6/73 - 6/76	Research Fellow, Department of Community Medicine Mount Sinai School of Medicine, New York
6/73 - 6/76	Resident in Occupational and Environmental Medicine Environmental Sciences Laboratory Mount Sinai School of Medicine, New York
6/72 - 6/73	Straight Medical Internship, Department of Medicine Montefiore Hospital and Medical Center, Bronx, NY

ACADEMIC RECORD

1968	B.A., Stanford University, Stanford, CA
1972	M.D., University of Wisconsin Medical School, Madison.

SPECIALTY BOARD CERTIFICATION

1977	American Board of Preventive Medicine Sub-specialty - Occupational and Environmental Medicine
1983	Fellow, American College of Epidemiology
1985	Certified "B" Reader for Pneumoconiosis Radiographs under Federal Mine Safety and Health Act of 1977 and its amendments. Recertified July 1989, July 1993, July 1997.

1. Lilis R, Anderson H, Nicholson WJ, Daum S, Fischbein AS, Selikoff IJ. Prevalence of disease among vinyl chloride and polyvinyl chloride workers. *Ann NY Acad Sci* 246:22-41, 1975.
2. Anderson HA, Daum SM, Fischbein AS, Selikoff IJ. Household-contact asbestos neoplastic risk. *Ann NY Acad Sci* 271:311-23, 1976.
3. Lilis R, Anderson HA, Miller A, Selikoff IJ. Pulmonary changes among vinyl chloride polymerization workers. *Chest* 69:299S-303S, 1976.
4. Lorimer WV, Lilis R, Nicholson WJ, Anderson H, Fischbein A, Daum S, Rom W, Rice C, Selikoff IJ. Clinical studies of styrene workers: initial findings. *Environ Health Perspect* 17:171-81, 1976.
5. Daum SM, Anderson HA, Lilis R, Lorimer WV, Fischbein AS, Miller A, Selikoff IJ. Pulmonary changes among titanium workers. *R Soc Med Sec Occup Med* 70.1:31-32, 1977.
6. Lilis R, Anderson H, Miller A, Selikoff IJ. Modifications pulmonaires et exposition au chlorure et polychlorure de vinyle. *Med et Hyg* 35, Geneve, 1542-45, 1977.
7. Lilis R, Fischbein A, Diamond S, Anderson HA, Blumberg WE, Eisinger J, Selikoff IJ. Lead effects among secondary lead smelter workers with blood lead levels below 80 @g/100 ml. *Arch Environ Health* 32.6:256-266, 1977.
8. Lilis R, Fischbein A, Eisinger J, Blumberg WE, Diamond S, Anderson HA, Rom W, Rice C, Sarkozi L, Kon S, Selikoff IJ. Prevalence of lead disease among secondary lead smelter workers and biological indicators of lead exposure. *Environ Res* 14:255-85, 1977.
9. Rom W, Anderson HA. Case report. *Clinical Notes on Respiratory Diseases* 15-16, Summer 1977.
10. Valciukas JA, Lilis R, Anderson H, Wolff M. Central nervous system dysfunction in a farm population accidentally exposed to polybrominated biphenyls: results of a clinical field survey. *Activ Nerv Sup (Praha)* 19.Suppl 2:434, 1977.
11. Anderson HA, Chahinian P, Churg J, Daum S, Hammond EC, Rabin C, Seidman H. Part III: Neoplastic effects. In: *Asbestos and Disease* (Selikoff IJ and Lee DHK, eds.) 241-336. Acad Press, New York, 1978.
12. Lilis R, Anderson HA, Valciukas JA, Freedman S, Selikoff IJ. Comparison of findings among residents on Michigan dairy farms and consumers of produce purchased from these farms. *Environ Health Perspect* 23:105-09, 1978.
13. Anderson HA, Wolff MS, Fischbein AS, Selikoff IJ. Investigation of the health status of Michigan Chemical Corporation employees. *Environ Health Perspect* 23:187-91, 1978.

- in Michigan and Wisconsin dairy farmers. *Environ Health Perspect* 23:195-201, 1978.
15. Valciukas JA, Lilis R, Wolff MS, Anderson HA. Comparative neurobehavioral study of a polybrominated biphenyl-exposed population in Michigan and a nonexposed group in Wisconsin. *Environ Health Perspect* 23:199-210, 1978.
 16. Anderson HA, Lilis R, Selikoff IJ, Rosenman KD, Valciukas JA, Freedman S. Unanticipated prevalence of symptoms among dairy farmers in Michigan and Wisconsin. *Environ Health Perspect* 23:217-26, 1978.
 17. Wolff MS, Haymes N, Anderson HA, Selikoff IJ. Family clustering of PBB and DDE values among Michigan dairy farmers. *Environ Health Perspect* 23:315-19, 1978.
 18. Anderson HA, Holstein EC, Daum SM, Sarkozi L, Selikoff IJ. Liver function tests among Michigan and Wisconsin dairy farmers. *Environ Health Perspect* 23:333-39, 1978.
 19. Anderson HA, Selikoff IJ. Pleural reactions to environmental agents. *Fed Proc* 37.11:2496-2500, 1978.
 20. Anderson HA, Snyder J, Lewinson T, Woo C, Lilis R, Selikoff IJ. Levels of CEA among vinyl chloride and polyvinyl chloride exposed workers. *Cancer* 42:1560-67, 1978.
 21. Bekesi JG, Holland JF, Anderson HA, Fischbein AS, Rom W, Wolff MS, Selikoff IJ. Lymphocyte function of Michigan dairy farmers exposed to polybrominated biphenyls. *Science* 199:1207-09, 1978.
 22. Naseem SM, Tishler PV, Anderson HA, Selikoff IJ. Aryl hydrocarbon hydroxylase in asbestos workers. *Am Rev Respir Dis* 118:693-700, 1978.
 23. Lorimer WV, Lilis R, Fischbein A, Daum S, Anderson H, Wolff MS, Selikoff IJ. Health status of styrene-polystyrene polymerization workers. *Scand J Work Environ & Health* 4:Suppl 2:220-26, 1978.
 24. Wolff MS, Anderson HA, Rosenman KD, Selikoff IJ. Equilibrium of polybrominated biphenyl (PBB) residues in serum and fat of Michigan residents. *Bull Environ Contam Toxicol* 21:775-81, 1979.
 25. Wolff MS, Aubrey B, Anderson HA, Camper F, Nikaido MN, Daum SM, Haymes N, Selikoff IJ. Analysis of adipose tissue and serum from PBB (polybrominated biphenyl)-exposed workers. *J Environ Pathol Toxicol* 2:1397-1411, 1979.
 26. Valciukas JA, Lilis R, Anderson HA, Wolff MS, Petrocci M. The neurotoxicity of polybrominated biphenyls: results of a medical field survey. *Ann NY Acad Sci* 320:337-67, 1979.
 27. Anderson HA, Wolff MS, Lilis R, Holstein EC, Valciukas JA, Anderson KE, Petrocci M, Sarkozi L, Selikoff IJ. Symptoms and clinical abnormalities following ingestion of polybrominated- biphenyl-contaminated food products. *Ann NY Acad Sci* 320: 684-702, 1979.

- Immunologic dysfunction among PBB-exposed Michigan dairy farmers. *Ann NY Acad Sci* 320:717-28, 1979.
29. Bekesi JG, Roboz J, Anderson HA, Roboz JP, Fischbein AS, Selikoff IJ, Holland JF. Impaired immune function and identification of polybrominated biphenyls (PBB) in blood compartments of exposed Michigan dairy farmers and chemical workers. *Drug Chem Toxicol* 1979; 2.1,2:179-91, 1979.
 30. Lilis R, Daum S, Anderson H, Sirota M, Andrews G, Selikoff IJ. Asbestos disease in maintenance workers of the chemical industry. *Ann NY Acad Sci* 330:127-35, 1979.
 31. Anderson HA, Lilis R, Daum SM, Selikoff IJ. Asbestosis among household contacts of asbestos factory workers. *Ann NY Acad Sci* 330:387-99, 1979.
 32. Anderson HA, Selikoff IJ. Asbestos-as-sociated radiographic changes among household contacts of amosite asbestos workers. In: *Induced Disease: Drug, Irradiation, Occupation* (Leslie Preger, ed.) 253-73. Grune and Stratton, New York, 1979.
 33. Anderson H, Lilis R, Daum S, Fischbein A, Selikoff IJ. Household exposure to asbestos and risk of subsequent disease. In: *Dusts and Disease*. (Lemen R and Dement JM, eds.) 145-56. Pathotox Publishers, Park Forest South, IL, 1979.
 34. Rosenman KD, Anderson HA, Selikoff IJ, Wolff MS, Holstein E. Spermatogenesis in men exposed to the fire retardant polybrominated biphenyls (PBB). *Fertility and Sterility* 32.2:209-13, 1979.
 35. Selikoff IJ, Anderson, HA. A survey of the general population of Michigan for health effects of polybrominated biphenyl exposure. Report to the Michigan Department of Public Health, Environmental Sciences Laboratory, Mount Sinai School of Medicine, New York, 1979.
 36. Lilis R, Daum S, Anderson H, Andrews G, Selikoff IJ. Asbestosis among maintenance workers in the chemical industry and oil refinery workers. In: *Biological Effects of Mineral Fibers*, Vol. 2, IARC Pub. 30:795-810, Lyon, France, 1980.
 37. Miller A, Elliott JC, Thornton JC, Warshaw R, Geiger M, Anderson H. Comparison of spirometry performed on the same subjects by two teams using similar instruments: an investigation of variability in prevalence of impairment. *Environ Res* 21:229-34, 1980.
 38. Valciukas JA, Lilis R, Singer R, Fischbein A, Anderson HA, Glickman L. Lead exposure and behavioral changes: comparison of four occupational groups with different levels of lead absorption. *Am J Ind Med* 1.3/4:421-26, 1980.
 39. Anderson, HA. Irritant gases and fumes. In: *Public Health and Preventive Medicine*, 11th ed. (Last, JM, ed.) 11th Edn, 760-70. Appleton Century Crofts, New York, 1980.
 40. Wolff MS, Anderson HA, Selikoff IJ. Human tissue burdens of halogenated aromatic chemicals in Michigan. *JAMA* 247.15:2112-16, 1982.

and modified pararosaniline methods for the determination of formaldehyde in air. *Environ Inter* 8:159-66, 1982.

42. Chanda JJ, Anderson HA, Glamb RW, Lomatch DL, Wolff MS, Voorhees JJ, Selikoff IJ. Cutaneous effects of exposure to Polybrominated Biphenyls (PBBs): the Michigan PBB incident. *Environ Res* 29:97-108, 1982.
43. Miller A, Thornton JC, Warshaw R, Anderson H, Teirstein AS, Selikoff IJ. Single breath diffusing capacity in a representative sample of the population of Michigan, a large industrial state: predicted values, lower limits of normal and frequencies of abnormality by smoking history. *Am Rev Respir Dis* 127:270-77, 1983.
44. Anderson HA, Selikoff IJ, Lilis R, Seidman H. Morbidity and mortality among household contacts of amosite asbestos exposed factory workers. *Proc World Symposium on Asbestos*. Pub. Canadian Asbestos Information Centre, Montreal, Canada 349-62, 1983.
45. Anderson HA. Asbestos: the public health perspective on state of the art. *Proc Environmental epidemiology and toxicology: practical applications at the state level*. ASTHO Foundation, Kensington, MD 69:39-42, 1983.
46. Weiss H, Anderson HA. A practical method of determining public health priorities in response to groundwater chemical contamination: the experience of the Wisconsin Division of Health. *Proc Internatl Mtg Israel Ecol Soc, Jerusalem in Develop Ecol Environ Quality* 2:205-13, 1983.
47. Anderson HA, Dally KA, Hanrahan LP, Eckmann AD, Kanarek MS, Rankin J. The epidemiology of mobile home formaldehyde vapor concentration and residents' health status. EPA-905/1-83-001. Feb 1983.
48. Moses M, Lilis R, Crow KD, Thornton J, Fischbein A, Anderson HA, Selikoff IJ. Health status of workers with past exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin in the manufacture of 2,4,5-trichloro-phenoxyacetic acid: comparison of findings with and without chloracne. *Am J Ind Med* 5:161-82, 1984.
49. Goldberg RL, Anderson HA. Occupational noise-induced hearing loss in Wisconsin. *Wis Med J* 83:13-15, 1984.
50. Hanrahan LP, Dally KA, Anderson HA, Kanarek MS, Rankin J. Formaldehyde vapor in mobile homes: a cross sectional survey of concentrations and irritant effects. *Am J Public Health* 74.9:1026-27, 1984.
51. Anderson HA. Utilization of adipose tissue biopsy in characterizing human halogenated hydrocarbon exposure. *Environ Health Perspect* 60:127-31, 1985.
52. Kilburn KH, Lilis R, Anderson HA, Boylen CT, Einstein HE, Johnson S-JS, Warshaw R. Asbestos disease in family contacts of shipyard workers. *Am J Public Health* 75.6:615-17, 1985.

- preventive methods. *J Public Health Dent* 45.3:180-86, 1985.
54. Anderson HA. Evolution of environmental epidemiologic risk assessment. *Environ Health Perspect* 62:389-92, 1985.
 55. Hanrahan LP, Anderson HA, Dally KA, Eckmann AD, Kanarek MS. Formaldehyde concentrations in Wisconsin mobile homes. *J Air Pollution Control Assoc* 35:1164-67, 1985.
 56. Anderson HA, Belluck D, Sinha SK. Public health related groundwater standards: summary of scientific support documentation for NR 140.10, Wisconsin DHSS, DOH, 1985.
 57. Anderson HA. The role of state and territorial epidemiologists. *Proc US Dept of Labor, Bureau of Labor Statistics Symposium towards improved measurement and reporting of occupational illness and disease, Albuquerque, NM, Dec 11-12, 1985.*
 58. Fiore, MC, Anderson HA, Hong R, Golubjatnikov R, Seiser JE, Nordstrom D, Hanrahan L, Belluck D. Chronic exposures to aldicarb-contaminated ground-water and human immune function. *Environ Res* 41:633-45, 1986.
 59. Ziamik M, Otto W, Sieger T, Gannon C, Anderson H. Ammonia contamination in a milk processing plant - Wisconsin. *MMWR* 35.17:274-5, 1986.
 60. Kilburn KH, Lillis R, Anderson HA, Miller A, Warshaw RH. Interaction of asbestos, age and cigarette smoking in producing radiographic evidence of diffuse pulmonary fibrosis. *Am J Med* 80:377-81, 1986.
 61. Anderson HA, Hanrahan LP, Jensen M, Laurin D, Yick W, Wiegman, P. Wisconsin Vietnam veteran mortality study: proportionate mortality ratio results: standardized mortality ratio results. Final report WI DHSS, DOH, Section of Environmental and Chronic Disease Epidemiology, March 1986.
 62. Saftlas AF, Blair A, Cantor KP, Hanrahan L, Anderson HA. Cancer and other causes of death among Wisconsin farmers. *Am J Ind Med* 11:119-29, 1987.
 63. Rogan WJ, Gladen BC, Ragan NB, Anderson HA. US prevalence of occupational pleural thickening: a look at chest x-rays from the first national health and nutrition examination survey. *Am J Epidemiol* 126.5:893-900, 1987.
 64. Sauter SL, Chapman LJ, Knutson SJ, Anderson HA. Case example of wrist trauma in keyboard use. *Applied Ergonomics* 18.3:183-86, 1987.
 65. Miller A, Thornton JC, Selikoff IJ, Anderson HA. Clinical respiratory abnormalities in Michigan: prevalence of clinical respiratory abnormalities by sex and smoking history in a representative sample of the adult population. *Chest* 94.6:1187-94, 1988.
 66. Horvath EP, Anderson H, Pierce WE, Hanrahan L, Wendlick JD. Effects of formal-dehyde on the mucous membranes and lungs: a study of an industrial population. *JAMA* 259.5:701-707, 1988.

complex problem. Arch Environ Health 43.2:166-69, 1988.

68. Martin JR, Muir DCF, Moore E, Edwards AC, Becklake M, Morgan KW, Anderson H, Edstrom H, Rusted IE, Segovia J. Pneumoconiosis in iron ore surface mining in Labrador. JOM 30.10:780-84, 1988.
69. Schmidt J, Rubenstein M, Sonzogni W, Schirmer J, Anderson H. PCB contamination of ceiling tiles - Madison, Wisconsin. MMWR 37.2:17-19, 1988.
70. Belluck DA, Anderson HA. Wisconsin's risk assessment based numerical ground-water standards program. Proc Agrichemicals and groundwater protection: resources and strategies for state and local management, Freshwater Foundation, Navarre, MN, 239-53, 1989.
71. Salmi LR, Weiss HB, Peterson PL, Spengler RF, Sattin RW, Anderson HA. Fatal farm injuries among young children. Pediatrics 83.2:267-71, 1989.
72. Fiore BJ, Anderson HA, Hanrahan LP, Olson LJ, Sonzogni, WC. Sport fish consumption and body burden levels of chlorinated hydrocarbons: a study of Wisconsin anglers. Arch Environ Health 44.2:82-88, 1989.
73. Anderson, HA. General population exposure to environmental concentrations of halogenated biphenyls. In: Halogenated Biphenyls, Terphenyls, Naphthalenes, Dibenzodioxins and Related Products (Kimbrough RD and Jensen AA, eds.) 2nd Edn, 325-344. Elsevier, Amsterdam, 1989.
74. Bunge M, Anderson HA, Davis JP. Injuries associated with ultraviolet tanning devices - Wisconsin. MMWR 38.19:333-35, 1989.
75. Remington PL, Anderson HA. Trends in cigarette smoking - Wisconsin, 1950-1988. MMWR 38.44:752-54, 1989.
76. Anderson HA, Higgins D, Hanrahan LP. Project SENSOR: Occupational disease and injury surveillance. Wis Med J 88:35-38, 1989.
77. Anderson HA. When domestic water is no longer potable. Health Environ Digest 3.6:4-5, 1989.
78. Anderson H, Belluck D. Exercising discretion. Environ Risk, pub Wis DNR:28, 1989.
79. Schirmer J, Anderson HA. Surveillance for occupational lung disease related to dust exposure in Wisconsin: the pneumoconioses and malignant mesothelioma. Wis Epidem Bull 11.2:1-3, 1989.
80. Mirkin IR, Anderson HA, Hanrahan L, Hong R, Golubjatnikov R, Belluck D. Changes in T-lymphocyte distribution associated with ingestion of aldicarb-contaminated drinking water: a follow-up study. Environ Res 51:35-50, 1990.

- for prevention. *Wis Med J* 89.2:49-53, 1990.
82. Anderson HA, Remington PL, Hanrahan LP, Haskins LK. Surveillance of environmental disease: the Wisconsin initiative. *Wis Med J* 89.3:120,122-,124, 1990.
83. Anderson HA, Belluck, DA, Olson, LJ. Final public health related groundwater standards: summary of scientific support documentation for NR 140.10 - cycle 3, Wisconsin DHSS, DOH, August 1990.
84. Akgulian NA, Moss ME, Remington PL, Anderson HA, Shultz JM. Alcohol-related disease impact - Wisconsin, 1988. *MMWR* 39.11:178-80,185-87, 1990.
85. Fiore BJ, Hanrahan LP, Anderson, HA. State health department response to disease cluster reports: a protocol for investigation. *Am J Epidemiol* 132:S14-S22, 1990.
86. Hanrahan LP, Mirkin I, Olson J, Anderson HA, Fiore BJ. SMRFIT: a statistical analysis system (SAS) program for standardized mortality ratio analyses and Poisson regression model fits in community disease cluster investigations. *Am J Epidemiol* 132:S116-S122, 1990.
87. Sitter RR, Hanrahan LP, Demets D, Anderson, HA. A monitoring system to detect increased rates of cancer incidence. *Am J Epidemiol* 132:S123-S130, 1990.
88. Young MR, Anderson DE, Anderson HA. Professional education for evaluating environmental exposure. *Wis Med J* 89.8:471-74, 1990.
89. Schirmer J, Anderson HA, Haskins L, Hanrahan L, Olson J. Epidemiologic surveillance by a state Health Department using the ILO classification system for pneumoconioses. DHHS (NIOSH) Pub 90-108 Part 1:807-12, 1990.
90. Remington PL, Anderson, DE, Manering MC, Peterson, EA, Anderson H. The PRECEDES project: background and methods. *Wis Med J* 89.12:695-96, 1990.
91. Sonzogni W, Maack L, Gibson T, Degenhardt D, Anderson H, Fiore B. Polychlorinated biphenyl congeners in blood of Wisconsin sport fish consumers. *Arch Environ Contam Toxicol* 20:56-60, 1991.
92. Schirmer J, Anderson H, Peterson, DE. Childhood lead exposure in Wisconsin in 1990. *Wi Med J* 90.1:31,33-35, 1991.
93. Remington P, Anderson H, Hanrahan, Haskins, L. Risk factors for lung cancer: a pilot study in five counties. *Wi Med J* 90.3:122,124, 1991.
94. Hanrahan LP, Higgins D, Anderson H, Haskins L, Tai S. Project SENSOR: Wisconsin surveillance of occupational carpal tunnel syndrome. *Wi Med J* 90.2:80,82-83, 1991.
95. Anderson HA, Goldring J, Knobeloch L. Groundwater protection. The Department of Health and Social Service role past present and future. *Proc. Wisconsin Groundwater conference. Univ. of Wisconsin, Stevens Point, Wi.* 15-16, 1991.

96. Saryan LA, Schirmer J, Anderson HA. Fatal pediatric poisoning from leaded paint - Wisconsin, 1990. *MMWR* 40.12:193-95, 1991.
97. Knobelock L, Anderson HA, Baum L. Acute effect of indoor exposure to paint containing bis(tributyltin) oxide - Wisconsin, 1991. *MMWR* 40.17:280-281, 1991.
98. Zvara JA, Anderson DE, Remington PL, Anderson H. Data-based cancer control programs: a public health response. *Wi Med J* 90.5:235-36, 1991.
99. Reding D, Anderson H, Lappe K, Hanrahan L, Haskins, L. Wisconsin farmers' cancer control project. *Wi Med J* 90.7:443-45, 1991.
100. Anderson HA, Hanrahan L, Phillips JL. Malignant mesothelioma in Wisconsin, 1959-1989. *Wi Med J* 90.8:479-80, 1991.
101. Windau J, Rosenman K, Anderson H, Hanrahan L, Rudolph L, Stanbury M, Stark A. The identification of occupational lung disease from hospital discharge data. *JOM* 33.10:1060-66, 1991.
102. Anderson HA, Hanrahan LP, Schirmer J, Higgins D, Sarow P. Mesothelioma among employees with likely contact with in-place asbestos-containing building materials. *Ann NY Acad Sci* 643:550-572, 1991.
103. Peterson DE, Zeger SL, Remington PL, Anderson HA. The effect of state cigarette tax increases on cigarette sales, 1955 to 1988. *Am J Pub Health* 82.1:94-96, 1992.
104. Hanrahan LP, Higgins D, Haskins L, Anderson H. Project FACE: Wisconsin surveillance of fatal occupational injuries. *Wi Med J* 91.1:43-46, 1992.
105. Anderson HA, Goldring, JM, Knobelock, LM. Final public health related groundwater standards: summary of scientific support documentation for NR 140.10 - cycle 4, Wisconsin DHSS, DOH, February 1992.
106. Raemisch RF, Listug DL, Norwick JM, Black J, Loveland R, Krause H, Anderson HA, Remington P. Cigarette smoking bans in county jails - Wisconsin, 1991. *MMWR* 41.6:101-103, 1992.
107. Peterson DE, Remington PL, Anderson HA. Letter to Ed Re: Vasectomy and the risk of prostate cancer. *Am J Epidemiol*:135.3:324-25, 1992.
108. Smith W, Anderson T, Anderson HA, Remington PL. Nitrogen dioxide and carbon monoxide intoxication in an indoor ice arena - Wisconsin, 1992. *MMWR* 41.21:383-385, 1992.
109. Anderson HA, Goldring, JM, Knobelock, LM. Recommended groundwater enforcement standards and preventive action limits: summary of scientific support documentation for NR 140.10 - cycle 5, Wisconsin DHSS, DOH, October 1992.
110. Pezzino G, Remington PL, Anderson H, Lantz PM, Peterson DE. Impact of a smoke-free policy on prisoners in Wisconsin, United States. *Tobacco Control* 1:180-184, 1992.

111. Anderson HA, Hanrahan LP, Higgins D, Sarow, PG. A radiographic survey of public school building maintenance and custodial employees. *Environ Res* 59:159-166, 1992.
112. Dar E, Kanarek MS, Anderson HA, Sonzogni, WC. Fish consumption and reproductive outcomes in Green Bay, Wisconsin. *Environ Res* 59:189-201, 1992.
113. Anderson HA. Surveillance - Agriculture-Related Diseases, Injuries and Hazards. *Proc. DHSS (NIOSH) Pub No.* 92-105, 1992.
114. Burke T, Anderson H et al. Role of exposure databases in risk management. *Arch Environ Health* 47.6:421-429, 1992.
115. Anderson HA, Higgins D, Hanrahan LA, Sarow. Adult occupational lead exposure in Wisconsin. *Wi Med J* 92.3:136-40, 1993.
116. Pezzino G, Remington PL, Anderson, HA. Prevalence and characteristics of weight loss attempts in Wisconsin, 1989. *Wi Med J* 92.8, 481-82, 1993.
117. Anderson H, Hanrahan L. Silicosis Surveillance - Wisconsin, 1987-1990. *MMWR* 42.SS-5:23-28, 1993.
118. Knobloch K, Krenz K, Anderson H, Hovel C. Methemoglobinemia in an Infant - Wisconsin, 1992. *MMWR* 42.:12, 217-218, 1993.
119. Hanrahan LP, Higgins D, Anderson H, Smith M. Wisconsin occupational carpal tunnel syndrome surveillance: the incidence of surgically treated cases. *Wi Med J* 92.12, 685-689, 1993.
120. Goldring JM, James DS, Anderson HA. Chapter 9: Chronic Lung Diseases. In: *Chronic Disease Epidemiology and Control* (Bronwson RC, Remington PL and Davis JR, eds.) 169-197. American Public Health Association, Washington DC, 1993.
121. Goldring J, Hanrahan L, Anderson H. Asthma hospitalizations in Wisconsin: public health implications. *Wi Med J* 93:2. 63-67, 1993.
122. Anderson, HA, Amrhein, JF, Shubat, P, Hesse, J. Protocol for a uniform Great Lakes sport fish consumption advisory. Great Lakes Sport Fish Advisory Task Force, Council of Great Lakes Goveroners, Chicago, IL, September, 1993.
123. Peterson DE, Kanarek MS, Kuykendall MA, Diedrich JM, Anderson HA, Remington PL, Sheffy TB. Fish consumption patterns and blood mercury levels in Wisconsin Chippewa Indians. *Arch Environ Health* 49.1:53-58, 1994.
124. Bongard J, Savage R, Dem R, Bostrum H, Kazmierczak J, Keifer S, Anderson H, Davis JP. Cryptosporidium infections associated with swimming pools - Dane County, Wisconsin, 1993. *MMWR* 43.31:561-63, 1994.
125. Knobloch L, Goldring J, LeMay W, Anderson H. Prilocaine-induced methemoglobinemia - Wisconsin, 1993. *MMWR* 43.35:655-657, 1994.

120. Knobeloch L, Ziamik M, Howard J, Hies D, Palmer D, Anderson HA, Dodson VN. Gastrointestinal upsets associated with ingestion of copper-contaminated water. *Environ Health Perspect* 102.11:2-5, 1994.
127. Pezzino F, Remington PL, Anderson HA, Hanrahan LP, Peterson DE. Smoking as a contributing cause of death in Wisconsin, United States, 1990. *Tobacco Control*; 3:120-123, 1994.
128. Peterson DE, Remington PL, Kuykendall MA, Kanarek MS, Diedrich JM, Anderson HA. Behavioral risk factors of Chippewa Indians living on Wisconsin reservations.- *Public Health Reports* 109.6,820-823, 1994-.
129. Stanbury M, Rosenman KD, Anderson HA. Guidelines: minimum and comprehensive state-based activities in occupational safety and health. DHSS (NIOSH) Publication No. 95-107, 1995.
130. Moss ME, Kanarek MS, Anderson HA, Hanrahan LP, Remington PL. Osteosarcoma, seasonality, and environmental factors in Wisconsin, 1970-1989. *Arch Environ Health* 50.3:235-214, 1995.
131. Anderson HA, Hanrahan LH, Goldring J, Delaney B. An investigation of health concerns attributed to reformulated gasoline use in southeastern Wisconsin: Phase 1 - Final Report. Wisconsin DHSS, DOH, BPH, May 30, 1995.
132. Knobeloch LM, Ziamik M, Anderson HA, Dodson VN. Imported Seabass as a source of Mercury exposure: a Wisconsin case study. *Environ Health Perspect* 103.6:604-606, 1995.
133. Anderson HA, Hanrahan LH, Goldring J, Delaney B. An investigation of health concerns attributed to reformulated gasoline use in southeastern Wisconsin: Phase 2, telephone registered health concerns - Final Report. Wisconsin DHSS, DOH, BPH, September 18, 1995.
134. Thacker SB, Stroup DF, Parrish RG, Anderson HA. Surveillance in environmental public health: issues, systems, and sources. *Am J Public Health*, 86:633-638, 1996.
135. Anderson HA, Falk C, Fiore B, Hanrahan L, Humphrey HEB, Kanarek M, Long T, Mortensen K, Shelley T, Sonzogni W, Steele G, Tilden J. Consortium for the health assessment of Great Lakes sport fish consumption. *Toxicol and Industrial Health*, 12, Nos. 3/4, 369-373, 1996.
136. Anderson H, Forrester WR, Perrotta DM, Air Pollution and Respiratory Health Br, NCEH. Asthma surveillance programs in public health departments - United States. *MMWR* 45.37:802-804, 1996.
137. Hanrahan L, Anderson HA, Haskins, LK, Olson J, Lappe, K, Reding, D. Wisconsin farmer cancer mortality, 1981 to 1990: selected malignancies. *Journal of Rural Health* , 12:4:273-277, 1996.

Wisconsin, 1995. *Wi Med J* 96:5: 33-38, 1997.

139. Fox, JL, Gruetzmacher GR, Anderson HA, Moen T, Lupo J, Ingram-Stewart V, Barry J. Health hazard evaluation: hypersensitivity pneumonitis. OSHA Consultation Program Study No. 6114-0, WDHFS, DOH, BP H, PO Box 309, Madison, Wi., April 1997.
140. Brown CM, Anderson H, Finkel RA. Asthma: the states challenge. *Public Health Reports* 112.3, 198-205, 1997.
141. Tilden J, Hanrahan L, Anderson HA, Palit C, Olson J, MacKenzie W, and the Great lakes Consortium. Health Advisories for Consumers of Great Lakes Sport-Fish: Is the Message Being Received? *Environ Health Perspect* 105.12, 1997.
142. DeVoto E, Fiore BJ, Millikan R, Anderson HA, Sheldon L, Sonzogni WC, Longnecker MP. Correlations among human blood levels of specific PCB congeners and implications for epidemiologic studies. *Am J Ind Med.* 32:606-613, 1997.
143. Morris RD, Naumova EN, Goldring J, Hersch M, Munasinghe RL, Anderson H. Childhood asthma surveillance using computerized billing records: a pilot study. *Public Health Reports* 112.6, 506-512, 1997.
144. Anderson HA, Falk C, Hanrahan L, Olson J, Burse V, Needham L, Paschal D, Patterson D, Hill R, and the Great Lakes Consortium. Profiles of Great Lakes critical pollutants: a sentinel analysis of human blood and urine. *Environ Health Perspect* 106:279-289, 1998.
145. Zeitz P, Anderson H, Hughes B. Monitoring environmental disease - United States, 1997. *MMWR* 47.25:522-525, 1998.
146. Zacharisen MC, Kadambi AR, Schlueter DP, Kurup VP, Shack JB, Fox, JL, Anderson HA, Fink, JN. The spectrum of respiratory disease associated with exposure to metal working fluids. *JOEM* 40:7 640-647, 1998.
147. Knobeloch LM, Korthof S, Anderson HA. Never on a Saturday (or a Sunday): the case against using weekend urine specimens to assess arsenic exposure. *Wi Med J* 97:10, 46-48, 1998.
148. Anderson HA, Hanrahan LP, Falk C, Tilden J, Olson J, and the Great Lakes Consortium. Sport fish consumption: an important route of exposure to persistent chemical pollutants. *Eur J Oncol*, 3:4, 321-327, 1998.
149. Anderson HA, Schirmer J, Hanrahan LP, Higgins D, Sarow P. Asbestosis and mesothelioma surveillance: a paper manufacturing company sentinel event investigation. *Eur J Oncol*, 3:4, 379-383, 1998.
150. Fox JL, Anderson HA, Moen T, Gruetzmacher G, Hanrahan L, Fink JN. Metal working fluid-associated hypersensitivity pneumonitis: an outbreak investigation and case-control study. *Am J Ind Med.* 35:58-67, 1999.

drinking water wells in Wisconsin. Arch Environ Health 54.4, 242-247, 1999.

152. Falk C, Hanrahan L, Anderson HA, Kanarek MS, Draheim L, Needham L, Patterson DJr and the Great Lakes Consortium. Body burden levels of dioxin, furans, and PCBs among frequent consumers of Great Lakes sport fish, Academic Press, S19-S25, 1999.
153. Hanrahan LP, Falk, C, Anderson HA, Draheim L, Kanarek MS, Olson J and the Great Lakes Consortium. Serum PCB and DDE levels of frequent great lakes sport fish consumers: a first look. Academic Press, S26-S37, 1999.
154. Anderson H, Knobeloch L, Warzecha C. Public health hazard surveillance and response to arsenic contamination. In: Arsenic Exposure and Health Effects (Chappel WR, Abernathy CO and Calderon RL, eds.), 367-372, Elsevier, Amsterdam, 1999.

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EXHIBIT 26

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Office of Pesticides
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Washington, DC 20460

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Toxic Substances

Guidance for Controlling Asbestos-Containing Materials in Buildings



**GUIDANCE FOR CONTROLLING ASBESTOS-CONTAINING
MATERIALS IN BUILDINGS**

1985 EDITION

**Exposure Evaluation Division
Office of Toxic Substances
Office of Pesticides and Toxic Substances
U.S. Environmental Protection Agency
Washington, D.C. 20460**

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SUMMARY OF GUIDANCE

INTRODUCTION

Airborne asbestos contamination in buildings is a significant environmental problem. Various diseases have been linked with industrial exposure to airborne asbestos, and the extensive use of asbestos products in buildings has raised concerns about exposure to asbestos in nonindustrial settings. Surveys conducted by the Environmental Protection Agency (EPA) estimate that asbestos containing materials can be found in approximately 31,000 schools and 733,000 other public and commercial buildings in this country.

The presence of asbestos in a building does not mean that the health of building occupants is necessarily endangered. As long as asbestos-containing material (ACM) remains in good condition and is not disturbed, exposure is unlikely. When building maintenance, repair, renovation or other activities disturb ACM, or if it is damaged, asbestos fibers are released creating a potential hazard to building occupants. Although not required to do so by federal law, the prudent building owner will take steps to limit building occupants' exposure to airborne asbestos. In 1983 EPA prepared and distributed "Guidance for Controlling Friable Asbestos-Containing Materials in Buildings" (USEPA 1983a). Since this guidance was published, EPA has gathered additional information and has gained valuable experience through its continuing Asbestos-in-Buildings Program. The guidance document has been substantially revised to incorporate this new information and to reflect the comments and suggestions of building owners and other readers. EPA offers building owners guidance to understand the technical issues, determine if asbestos is present in a building, plan a control program, and choose the course of further action if necessary.

This summary is divided into two parts. The first is an introduction to the problem of asbestos in buildings and summarizes the material that is presented in Chapter 1. The second part of the summary provides a concise outline of the remainder of the report. It lists the major steps needed to determine whether asbestos is present in a building (Chapter 2), establish a special operations and maintenance (O&M) program (Chapter 3), assess the need for further action (Chapters 4 and 5), and carry out an abatement project (Chapter 6). It is intended as a checklist for the building owner.

ACM IN BUILDINGS

ACM in buildings is found in three forms: (1) sprayed or troweled on ceilings and walls (surfacing material); (2) in insulation around hot or cold pipes, ducts, boilers, and tanks (pipe and boiler insulation); and (3) in a variety of other products such as ceiling and floor tiles and wall boards (miscellaneous materials). In general, ACM in the first two categories is of greatest concern, especially if it is friable. (Friable material can be crumbled, pulverized, or reduced to powder by hand pressure.)

Testing for ACM is required in primary and secondary schools only. (Regulations are specified in "The Friable Asbestos-Containing Materials in Schools; Identification and Notification Rule.") At present, no parallel rule applies to other public or commercial buildings. Further, no Federal regulations require abatement actions (repair or removal, enclosure, encapsulation).

The OSHA (Occupational Safety and Health Administration) regulations specifying work practices and the EPA rules governing the handling and disposal of asbestos apply to abatement actions. State regulations on these issues vary and may be more stringent than federal requirements.

ASBESTOS CONTROL ACTIVITIES

The following pages outline the steps that a building owner should take to control asbestos. Each step is described in more detail in the body of the report.

Survey to See if Asbestos is Present

- Appoint an asbestos program manager and assemble a survey team.
- Check building records for evidence of asbestos-containing surfacing materials, pipe and boiler insulation, or miscellaneous ACM.
- Locate and document all ACM identified in building records.
- Inspect the building for friable materials on walls or ceilings. Inspection means touching walls and ceilings.
- Inspect the building for insulation on pipes and boilers. Inspection means looking at pipes and boilers.
- Be persistent. Friable materials may be hidden behind dropped ceilings or partitions.
- Collect samples of friable ceiling and wall materials following EPA procedures.
- Collect samples of pipe and boiler wrap if the insulation is exposed. Otherwise, assume the insulation contains asbestos.
- Send samples to a qualified laboratory for analysis by polarized light microscopy (PLM). If the samples show more than one percent asbestos, the building contains ACM.
- Document all findings.

Establish a Special Operations and Maintenance (O&M) Program

- Obtain cooperation of building maintenance and custodial managers.
- Educate building occupants and employees about ACM.
- Train custodial and maintenance workers in special cleaning techniques and maintenance precautions.
- Clean the building thoroughly using wet cleaning and HEPA-vacuum techniques.
- Repeat the cleaning monthly (near surfacing materials) or semi-annually (near wrapped insulation).
- Take special precautions before starting maintenance and construction work.
- Inspect ACM at least twice a year for evidence of damage or deterioration.
- Continue the O&M program until all ACM is removed.

Assess the ACM to Determine the Need for Further Action

- Assess the likelihood of fiber release from the ACM by evaluating its current condition and the potential for future disturbance, damage or erosion.
- Determine:

- The need for further action.
- When it should be done.
- What abatement method should be used.

Conduct Abatement Actions If Needed

- Hire an abatement contractor or, if in-house capabilities are available, use building staff.
- To select a contractor:
 - Write precise contract specifications.
 - Check references.
 - Conduct interviews.
 - Review insurance coverage.
 - Select the "best" contractor, not necessarily the lowest bidder.
- To Manage the work:
 - Inspect the work site at least four times a day to insure compliance with all prescribed work practices and worker protection measures. These include:
 - Construction of a containment barrier around the entire work area, or the use of containment bags for wrapped insulation.
 - Use of coveralls and respirators by the workers.
 - Provision of worker change and decontamination facilities.
 - Stop abatement work immediately if any condition of the worksite appears to be hazardous.
 - Release the contractor only after:
 - The work site has been thoroughly cleaned at least twice.
 - The work site passes a visual test for abatement completion and cleanliness.
 - The work site passes a test for airborne asbestos.

Construction materials containing asbestos have been used extensively in schools and other buildings. The concern about exposure to asbestos in these buildings is based on evidence linking various respiratory diseases with occupational exposure in the shipbuilding, mining, milling, and fabricating industries. The presence of asbestos in a building does not mean that the health of building occupants is endangered. If asbestos-containing material (ACM) remains in good condition and is unlikely to be disturbed, exposure will be negligible. However, when ACM is damaged or disturbed — for example, by maintenance or repairs conducted without proper controls — asbestos fibers are released. These fibers can create a potential hazard for building occupants.

This chapter describes ACM found in buildings and the potential health risks to occupants of buildings where ACM is present. Also, federal regulations addressing asbestos in buildings are briefly summarized.

SUMMARY

ACM In Buildings: Three forms of asbestos are typically found in buildings: (1) sprayed- or troweled-on surfacing materials; (2) insulation on pipes, boilers, and ducts; and (3) miscellaneous forms, such as wallboard, ceiling tiles, and floor tiles. EPA surveys estimate that 31,000 schools and 733,000 public and commercial buildings contain friable (easily crumbled) ACM. Friable ACM and ACM disturbed during maintenance, repair or renovation are of greatest concern from an exposure perspective.

Levels of Airborne Asbestos in Buildings and Other Settings: Prevalent levels of airborne asbestos inside buildings with ACM may be 10 to 100 times higher than outdoor levels. However, these indoor levels are typically 10,000 to 100,000 times lower than levels in asbestos industry workplaces where asbestos-related diseases have been well-documented.

Asbestos-Related Disease: Most people with asbestos-related diseases (asbestosis, lung cancer, and mesothelioma) were exposed to high levels of asbestos while working in asbestos industries prior to 1972. Extrapolation of the relationship between exposure level and disease indicates that only a small proportion of people exposed to low levels of asbestos will develop asbestos-related diseases. Smokers, children, and young adults are at somewhat greater risk.

Federal Regulations Regarding Asbestos in Buildings: Current regulations (1) restrict the use of most asbestos products in new buildings, (2) specify work practices for removal of ACM from buildings, and (3) require the identification of asbestos in schools. There are no exposure standards for nonindustrial settings, and no regulations requiring corrective actions in buildings with ACM.

1.1 Asbestos-Containing Materials in Buildings

Asbestos may be found in cement products, acoustical plaster, fireproofing textiles, wallboard, ceiling tiles, vinyl floor tiles, thermal insulation, and other materials.¹ EPA surveys estimate that 31,000 schools and 733,000 federal and commercial buildings have ACM in one form or another (USEPA 1984a, 1984b). ACM has been grouped into three categories: (1) sprayed- or troweled-on materials on ceilings, walls, and other surfaces; (2) insulation on pipes, boilers, tanks, ducts, and other equipment; and (3) other miscellaneous products. (Examples of ACM are shown in Figure 1.) Material in the first two categories can be friable, that is, it can be crumbled, pulverized, or reduced to powder by hand pressure. Most ACM in the third category is nonfriable.

¹ Descriptions of these and other types of products containing asbestos appear in Appendix A.

Although nonfriable ACM is of less immediate concern, it should not be ignored. Fibers will be released if nonfriable material is cut, drilled, sanded, or broken during building repairs or renovation.

1.2 Levels of Airborne Asbestos in Buildings and Other Settings

Levels of airborne asbestos in the asbestos industry workplace are substantially higher than levels found outdoors or in buildings with ACM. Figure 2 shows levels measured in the three settings: asbestos insulation plants before the 1972 Occupational Safety and Health Administration (OSHA) exposure standards, schools with ACM, and outdoor urban areas.² The range of values in each category reflects differences in location, source of asbestos, and variability in asbestos measurements. Concentrations may exceed the upper limits of these ranges for short periods if, for example, manufacturing equipment malfunctions, insulating material is pierced with a sharp object, or asbestos-coated surfaces are disturbed by the impact of a ball or similar object.

Figure 2 shows that prevalent concentrations of airborne asbestos in a sample of school buildings were approximately 10 to 100 times higher than outdoors. At the same time, asbestos levels in the schools were 10,000 to 100,000 times lower than pre-1972 levels in asbestos insulation workplaces.³

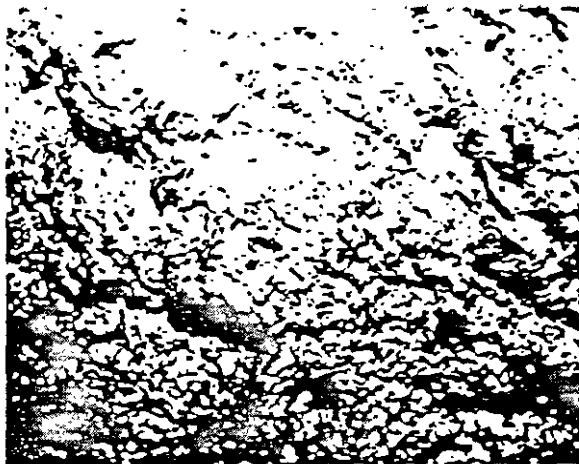
1.3 Diseases Associated with Exposure to Asbestos

Much of what is known about asbestos-related diseases comes from studying workers in the various asbestos industries. Exposure to levels of airborne asbestos typical of the asbestos workplace prior to 1972 has been linked with a debilitating lung disease called asbestosis; a rare cancer of the chest and abdominal lining called mesothelioma; and cancers of the lung, esophagus, stomach, colon, and other organs. In 1972 federal exposure standards were imposed.

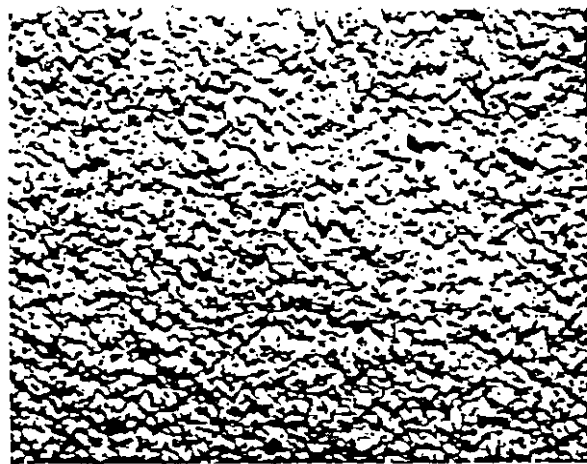
The relationship between exposure level and health risk is complex. The potential for disease appears to be related to the physical and chemical characteristics of asbestos fibers as well as to the concentration of fibers in the air. Data on asbestos workers indicate that the risks of asbestosis, lung cancer, and mesothelioma decrease in direct proportion to a decrease in total asbestos dose. Because there is no direct information on health risks from exposure to asbestos in buildings with ACM, the risks are estimated by extrapolation from studies of asbestos industry workers (Nicholson 1984, NRC 1984, The Royal Commission of Ontario 1984). The estimates indicate that only a small proportion of people exposed to low levels of asbestos will develop asbestos-related diseases. However, combining smoking with occupational exposure to asbestos increases the lung cancer rate above the rate due to either smoking or asbestos exposure alone. Also, asbestos exposure in children is of special concern: since they have a greater remaining lifespan than adults, their lifetime risk of developing mesothelioma is greater. Avoiding unnecessary exposure to asbestos is prudent.

² For comparison, all data are expressed in nanograms per cubic meter (ng/m³) units. Concentrations of asbestos fibers in the air are measured in terms of either the number of fibers per unit volume (typically, fibers per cubic centimeter) or the mass per unit volume (typically, ng/m³). A nanogram is one-billionth of a gram. See Appendix B for a simple explanation of measurement units used for airborne asbestos concentrations.

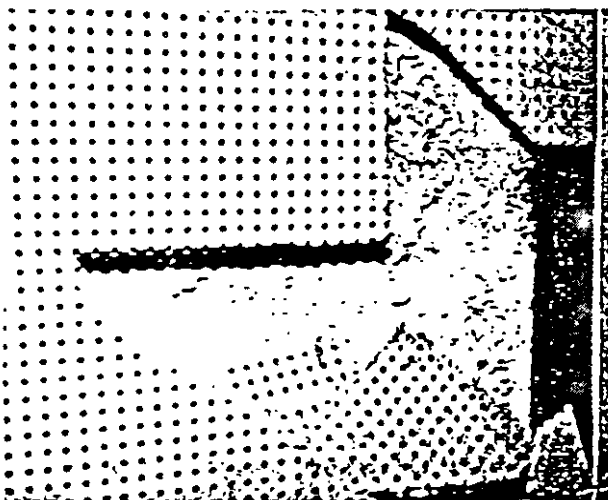
³ The data in Figure 2 should be interpreted with caution. Estimated concentrations in asbestos workplaces are based on measurements of airborne fibers using the method specified by OSHA (phase contrast microscopy), while the levels in schools and outdoors were measured by a different method (transmission electron microscopy). Comparisons of measurements obtained by the two methods are based on certain assumptions (see footnote to Figure 2). Measurement of airborne asbestos fibers is a complex subject and is discussed in more detail in Section 4.1.2.



Friable, fluffy sprayed-on material



Friable, cementitious sprayed-on or troweled material (acoustical plaster)



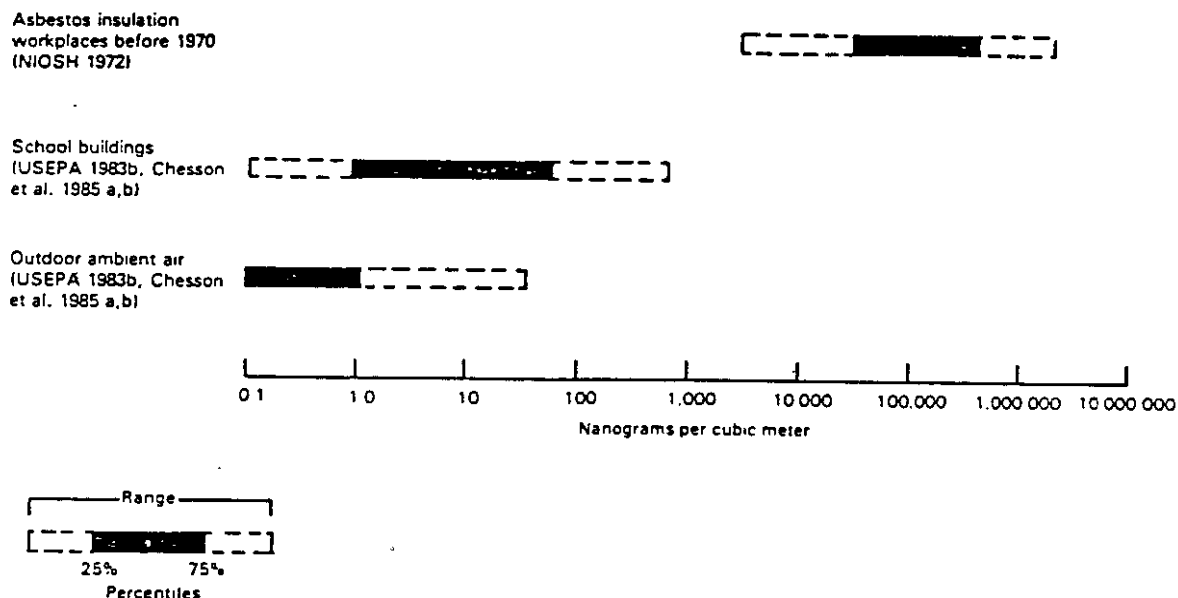
Nonfriable wallboard with friable sprayed-on material behind



Pipe lagging

Figure 1. Examples of asbestos-containing materials found in buildings.

Figure 2. Comparison of measured airborne asbestos concentrations in three settings.*



*Levels in asbestos workplaces were derived from measurements using phase contrast microscopy (PCM) while levels in school buildings and outdoors were measured using electron microscopy (EM). PCM and EM measurements are not directly comparable. PCM measures all fibers whereas EM can distinguish between asbestos and nonasbestos fibers. In addition, EM has a better capability than PCM for detecting small fibers. In order to translate the workplace PCM measurements (expressed as fiber counts) into values of asbestos mass (nanograms) that are approximately comparable to EM measurements, 30 fibers were assumed to equal one nanogram. This value is an average obtained from many comparisons of PCM and EM measurements taken at the same location (industrial settings) and time. Values for individual samples range from about 10 fibers per nanogram of asbestos to well over 100 fibers per nanogram, depending on the average size of fibers and the relative number of asbestos and nonasbestos fibers in the air (Versar 1980 and William Nicholson, personal communication, 1982).

1.4 Federal Regulations Regarding Asbestos in Buildings

Both EPA and OSHA have published regulations to reduce asbestos exposure. EPA regulations focus on: (1) application and removal of ACM in new or remodeled buildings, and (2) identification of friable asbestos in schools. EPA also regulates the industrial emission of asbestos fibers and the disposal of asbestos waste. OSHA addresses worker protection in the workplace.

The first EPA regulations were issued in 1973 under the National Emission Standards for Hazardous Air Pollutants (NESHAPS), as authorized by the Clean Air Act. The first regulations were directed largely at the asbestos industries, but also partially banned spray-applied ACM in new buildings, and established procedures for handling ACM during demolition. The regulations were revised in 1975 and 1978 to cover building renovations, the use of all types of insulating ACM in new buildings, and asbestos emissions from ACM waste disposal.⁴

Of particular interest to owners of buildings with ACM are the following regulations:

- When a building is demolished — or more than 260 linear ft. of asbestos pipe insulation or 160 sq. ft. of asbestos surfacing material are removed during renovation — advance notice must be filed with the EPA regional office and/or the state, giving:
 - name and address of the building owner or manager;
 - description and location of the building;
 - scheduled starting and completion dates of ACM removal;
 - description of the planned removal methods; and
 - name, address, and location of disposal site.
- ACM can be removed only with wet removal techniques (see Section 5.1). Dry removal is allowed only under special conditions and only with written EPA approval.
- No visible emissions of dust are allowed during removal, transportation, and disposal of ACM. (The wet removal techniques described in Section 5.1 are designed to satisfy this requirement.)

The entire text of the NESHAPS regulations appears in Appendix C. Before beginning any ACM removal or building demolition, the building owner should review the NESHAPS requirements in detail. More information can be obtained from the regional NESHAPS contact. Addresses and telephone numbers of the contacts are found in Appendix D.

The second set of EPA regulations is in the "Friable Asbestos-Containing Materials in Schools; Identification and Notification Rule," (40 CFR Part 763)⁵ promulgated under the Toxic Substances Control Act. Known as the Asbestos-in-Schools rule, it requires all primary and secondary schools, both public and private, to:

- inspect, sample, and analyze friable materials for asbestos;
- document all findings; and
- inform all school employees and the school's parent-teacher organization (or parents, if there is no organized group) of the location of friable ACM, and provide each custodial worker with a copy of the EPA publication, "A Guide for Reducing Asbestos Exposure," as published in the FEDERAL REGISTER (40 CFR Part 763).

⁴ The complete set of regulations was repromulgated on April 5, 1984.

⁵ The deadline for compliance with the Rule was June 28, 1983. A copy of the Rule is available from EPA. See Appendix E.

... for removal of ACM, engineering and administrative controls, workplace practices, and medical surveillance and worker protection requirements. In 1982, OSHA announced its intention to tighten the exposure standards. (See the "Calendar of Federal Regulations," published in the FEDERAL REGISTER [47 FR 1807].)* The OSHA regulations apply to all workplace activities involving asbestos, including removal of ACM from buildings. Future OSHA regulations may include separate exposure standards for ACM removal operations. The complete text of the OSHA regulations appears in Appendix F.

OSHA's worker exposure standards are inappropriate for nonindustrial settings. First, the standards were set to protect workers only against asbestosis, which does not occur at the lower exposure levels typical of buildings with ACM. Second, the measurement technique that determines OSHA compliance does not distinguish between asbestos and nonasbestos fibers and does not measure the small asbestos fibers typically found in buildings with ACM.

The measurement problem is not a major shortcoming in industrial settings where most airborne fibers are expected to be asbestos. However, only a few fibers in building air are asbestos, and the OSHA measurements may be misleading. (Other limitations of the OSHA technique further confound the measurement of airborne asbestos in buildings. See Section 4.1.2 for a more detailed discussion of measuring airborne asbestos.)

* As of July 1, 1976, the OSHA standards were set at 2 fibers per cubic centimeter averaged over 8 hours and a ceiling level not to exceed 10 fibers per cubic centimeter "at any time." OSHA is now evaluating the effect of lowering the 8-hour standard to either 0.5 or 0.2 fibers per cubic centimeter in order to protect workers against cancer, as published in the FEDERAL REGISTER (47 FR 1807).

CHAPTER 2 DETERMINING IF ASBESTOS-CONTAINING MATERIAL

To determine if ACM is present in a building, examine construction records and conduct a thorough inspection of building materials. If asbestos is not present, no further action is required. If asbestos is found, however, a control program should be initiated. In either case, workers and other building occupants will be concerned. The building owner must be prepared to explain the purpose of the survey, its results, and plans for controlling ACM if it is present.

SUMMARY

Planning the Survey: A plan for conducting the ACM survey should include assembling the survey team and gaining cooperation of building management. The plan should also include a public information program.

Conducting the Survey: The survey consists of checking building records and inspecting the building for evidence of ACM. Specific procedures differ for the three types of ACM, and may include sampling and analysis of suspect materials.

2.1 Planning the Survey

The survey has four components:

- Reviewing building records for references to asbestos used in construction or repairs;
- Inspecting materials throughout the building to identify those that may contain asbestos;
- Sampling suspect materials for laboratory confirmation that asbestos is present; and
- Mapping the locations of all confirmed or suspected ACM.

Thorough planning is essential because:

- The survey must provide accurate and reliable information;
- Questions from building occupants or the public about the survey and about asbestos in general must be answered quickly and responsively;
- Complete, accurate, unambiguous documentation of the survey and all test results is critical; and
- If ACM is found, the building owner must be prepared to initiate special operations and maintenance (O&M) practices immediately, and to develop other controls to minimize health risks (see Chapter 3).

The importance of a well-planned public communications program cannot be over-emphasized. Asbestos is an exceptionally emotional issue. A building owner must clearly understand the purpose of the survey in order to anticipate and address the concerns of building occupants and the public.

2.1.1 Assembling the Survey Team

Owners are ultimately responsible for asbestos-related problems in their buildings. The owner should appoint an asbestos program manager to direct all asbestos-related activities. The asbestos program manager

The asbestos program manager should communicate directly with the building owner. In addition, if ACM is present, the asbestos program manager will oversee the development of the asbestos control program, and provide information to the public. The manager needs to become familiar with the use of ACM in buildings, the potential for building contamination by airborne asbestos, the health risks to building occupants, and options for controlling ACM. The manager needs a general understanding of all the issues in order to review technical tasks and judge whether they are being performed properly. If the building owner has no experienced person on his staff, he should consider hiring a qualified consultant.

The program manager's responsibilities include:

- Implementing a training program for the ACM survey if the survey is to be conducted in-house;
- Selecting a technical advisor to conduct the ACM survey if an outside consultant is needed;
- Selecting a laboratory to analyze samples of material from the building;
- Designing a system to document all information about asbestos in the building; and
- Developing a communications package for discussions with building occupants and others.

If ACM is found, the asbestos program manager should also be prepared to initiate special operations and maintenance (O&M) practices (see Chapter 3), assess the need for other control measures (see Chapters 4 and 5), and oversee abatement projects if additional corrective action is necessary (see Chapter 6). The duties and responsibilities of the manager continue until all ACM is removed from the building.

An asbestos survey team should be assembled under the direction of the asbestos program manager. Figure 3 illustrates the organization of the team. The building architect, the facilities (or physical plant) manager, and the head of building maintenance are obvious choices due to their knowledge of building records and facilities. Maintenance and engineering staffs may also be team members since they likely will conduct the survey. If an outside technical advisor is hired to conduct the survey, he or she would be a member of the team. Other team members acting primarily as special advisors would include an attorney and a risk manager (i.e., a person responsible for insurance).

As indicated by Figure 3, the asbestos program manager should seek advice from the EPA Regional Asbestos Coordinator (RAC). (Addresses and telephone numbers for the 10 RACs are listed in Appendix D.) The RAC has information on ACM surveys, technical advisors, consultants, laboratories for analyzing samples of building materials, training programs, and abatement contractors.

The asbestos program manager should attend one of the asbestos control training courses offered by universities and private organizations. Currently, EPA-sponsored programs are offered in conjunction with Georgia Institute of Technology, Kansas University and Tufts University. The RAC is the best source of further information regarding these programs and others which may be available in each Region.

If a technical advisor will be hired to conduct the survey, the asbestos program manager should require evidence of experience and/or training. Examine references, especially those provided by other building owners. Be sure the advisor has a reputation for being thorough. Most survey errors involve overlooking building areas where there could be ACM. Asbestos control advisors include specially trained engineers, architects, and industrial hygienists.

If ACM is found, the technical advisor may assist with the continuation of the control program. In that case, the advisor should also have experience in developing a special O&M program, assessing the need for additional corrective action, and monitoring abatement projects. Additional information on selecting technical advisors is provided in Chapters 3 and 4.

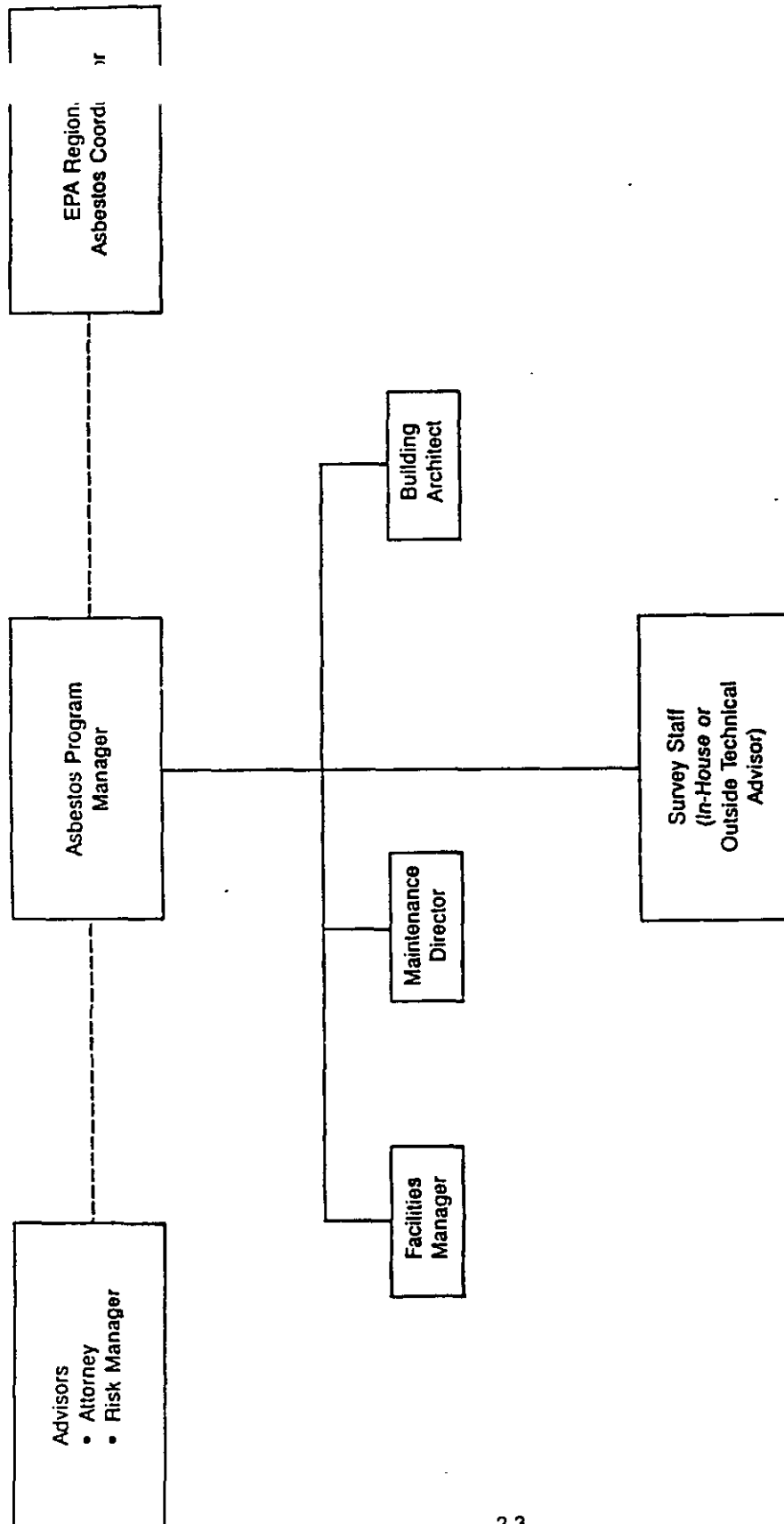


Figure 3. Composition of the ACM survey team.

2.1.2 Obtaining Cooperation

An ACM survey will be successful only if everyone in building management cooperates. Most importantly, the building owner must be convinced that exposure to asbestos is potentially a serious problem, and that a careful survey for ACM is needed. The asbestos program manager and the building owner must have a close working relationship.

Beyond this, cooperation must be obtained from building maintenance, operations, and planning personnel. A survey for ACM can disrupt normal building activities. Occupants will be concerned and curious. The survey team must be prepared to discuss the purpose of the survey in a way that is realistic, yet does not cause undue anxiety. Questions requiring a lengthy response should be referred to the program manager.

2.2 Conducting the Survey

The survey involves a review of building records and an inspection of the building for friable materials. The inspection is the more important component of the survey since building records are often incomplete and unreliable. Whenever the presence of asbestos is in doubt, prudence is recommended: treat the material as if it contains asbestos.

2.2.1 General Survey Elements

Figure 4 illustrates the survey steps. Begin by reviewing building records to see if ACM was specified at any stage. Although building records are often unreliable, they are a useful starting point. Check the original plans, shop drawings, remodeling records, and work change orders. Appendix A is a list of the most common uses and types of ACM in buildings since 1960. If any of these items appears in the records, assume that asbestos is in the building. Identify ACM mentioned in building records by type: (1) troweled- or sprayed-on surfacing material, (2) pipe and boiler insulation, or (3) other miscellaneous ACM.

Next, inspect the building for ACM identified in the building records. Determine if the materials are friable and record the findings. They may be sampled and analyzed to confirm the presence of asbestos. Thoroughly inspect all areas of the building for friable materials and sample them. The specific procedures for inspection and sampling vary depending on which of the three types of material are involved. The sampler of building materials should wear a respirator to prevent inhalation of fibers. (See Section 5.1 for information on respirators.)

2.2.2 Procedures for Sprayed- or Troweled-on Surfacing Materials

Surfacing materials can be friable or nonfriable. Friable forms are either very fibrous and fluffy (sometimes like cotton candy) or granular and cementitious (review Figure 1). Since friable materials are more likely than nonfriable materials to release fibers when disturbed, the first priority is to identify those friable surfacing materials that contain asbestos. As shown in Figure 5, the first step is to locate ACM specified in building records and determine its friability. Then, identify all friable surfacing materials in the building and take samples to be analyzed for asbestos.

2.2.2.1 Surfacing Materials Identified as ACM in Building Records

Begin by locating any acoustical plaster or other surfacing materials that, according to building records, contain asbestos. Rub these materials to see if they crumble or produce a light powder. If so, consider them friable. (When disturbing material that may contain asbestos, the inspector should wear protective equipment.) Either assume that these materials contain asbestos, or sample and analyze them, as discussed below. Record the location and degree of friability.

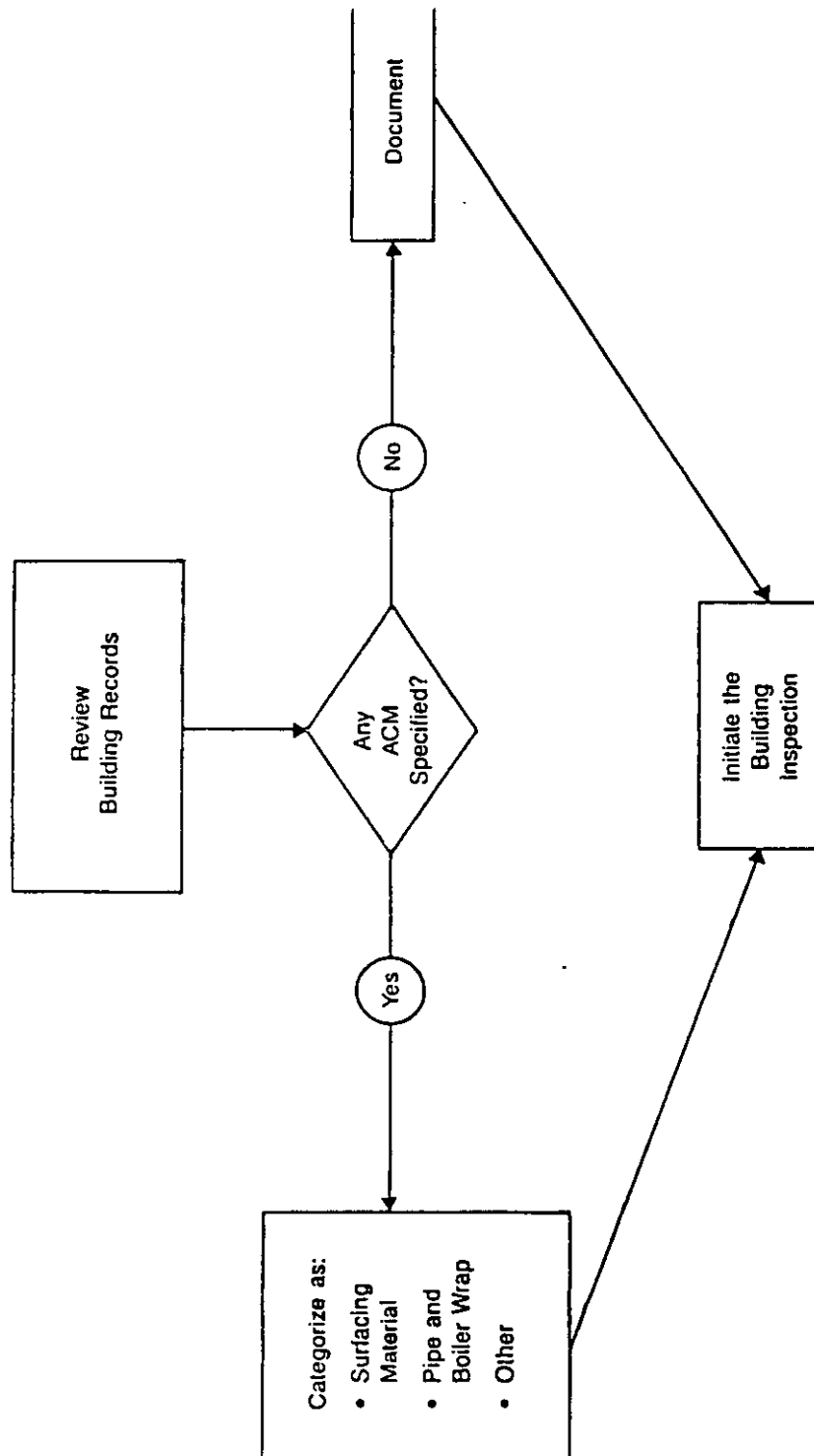


Figure 4. Initial Steps in an ACM Survey.

Conduct a thorough building inspection for friable materials on walls, ceilings, beams, ducts, and any other surface. Rub the material to see if it is friable. Following Figure 5, group any friable material into "homogeneous" areas for further study.¹ A homogeneous area contains friable material that seems by texture and color to be uniform. If materials appearing uniform were installed at different times, designate the two materials as distinct homogeneous areas.

Once homogeneous areas of friable materials have been delineated and recorded on floor plans, collect samples of the materials and send them to a qualified laboratory. Sampling and analysis should be conducted according to the following guidelines:²

- Appoint a coordinator to oversee the entire sampling and analysis operation and quality assurance program. The asbestos program manager or technical expert may assume this role.
- Choose a qualified laboratory to analyze the samples (see Appendix G.2). The approved method of bulk sample analysis for asbestos is polarized light microscopy. In certain cases, X-ray diffraction may be required to confirm the presence of asbestos.
- Collect at least three core samples of material in each homogeneous sampling area. Select sampling locations that are representative of the homogeneous area. (Either select locations evenly distributed throughout the area or choose the locations by a random selection method such as the one described in USEPA 1980a. It is important that three samples not be collected in the same location.) Remember that everyone taking samples should wear a respirator.
- Collect at least 1 quality control (QC) sample per building or 1 QC sample per 20 samples, whichever is larger. A QC sample is taken from the area abutting a regular sample. (The two samples are referred to as "side-by-side samples.") The QC sample should be analyzed at a second laboratory to confirm the results of the primary laboratory.
- Label all samples with an identifying code and keep a code log. To avoid bias, the laboratory analyst should not know the origin of the samples.
- Asbestos is present if the material analyzed is more than one percent asbestos by weight.

Record the results of the sampling and analysis program and save the records indefinitely. If no asbestos is found in these materials, no further action is necessary for this category of ACM. If asbestos is present, then an asbestos control program should be developed as described in Chapters 3 and 4.

2.2.3 Procedures for Pipe and Boiler Insulation

Asbestos-containing insulation is found on equipment containing hot air or liquid — pipes, boilers, tanks, and sometimes ducts. These insulation materials may be a chalky mixture of magnesia and asbestos, preformed fibrous asbestos wrapping, asbestos fiber felt, corrugated paper, or insulating cement. In most cases, the insulating material is covered with a protective jacket of cloth, tape, paper, metal, or cement.³

¹ The Asbestos-in-Schools rule allows schools to skip the sampling and analysis steps by assuming that any friable materials found in the building contain asbestos. The location of all friable materials must be documented and all affected parties must be notified whether asbestos is assumed to be present or confirmed by laboratory analysis. Nonfriable materials are not addressed by the Asbestos-in-Schools rule.

² Specific procedures for sampling and analyzing friable materials in schools were presented in the Asbestos-in-Schools rule. These procedures are consistent with the guidelines presented here.

³ ACM sprayed on ducts should be considered surfacing material.

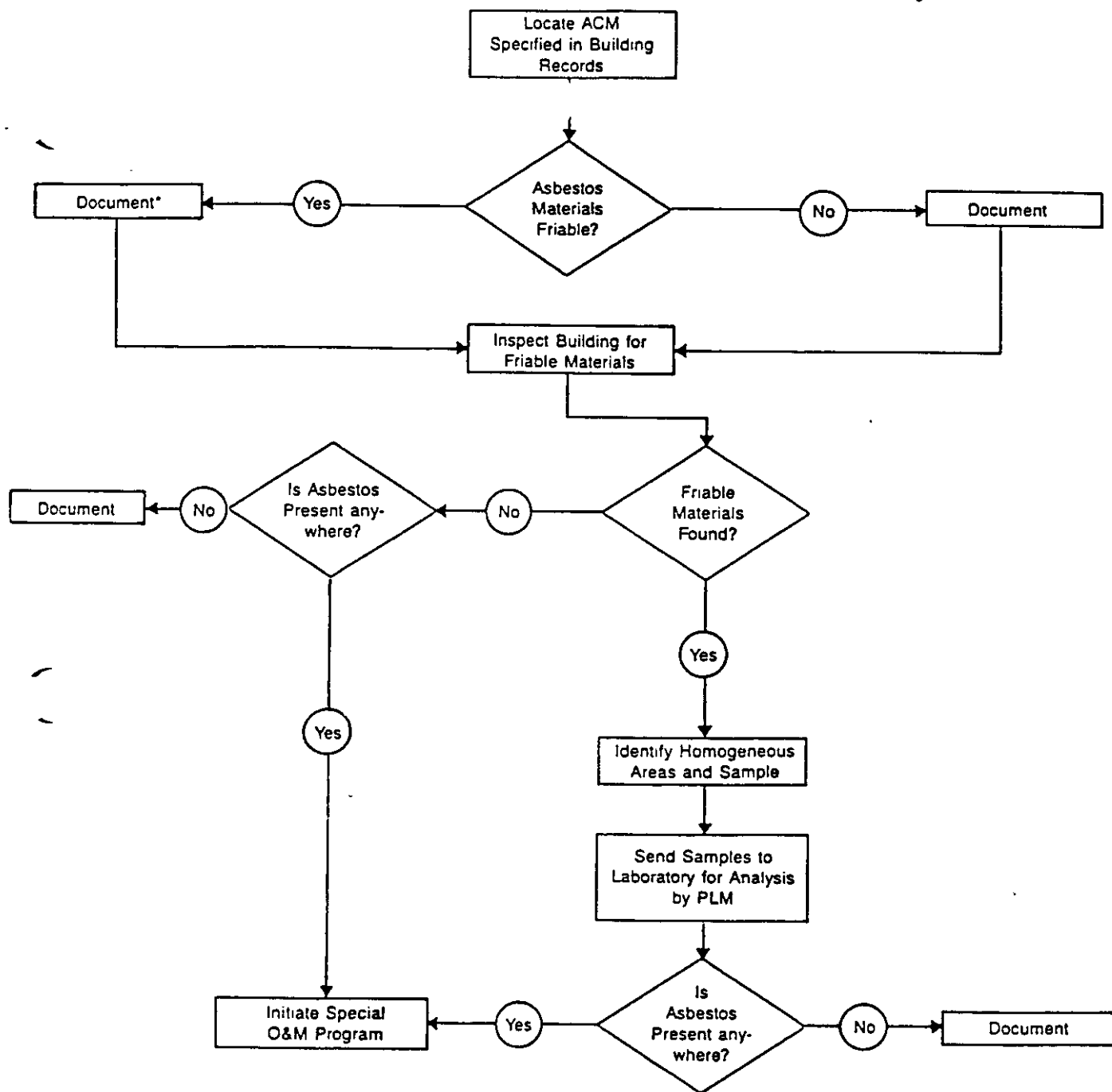


Figure 5. Survey procedures for sprayed- or troweled-on surfacing material.

*These materials can be sampled and analyzed to confirm that they do contain asbestos, and that a special O&M program is needed.

covered with finishing cement. Occasionally, asbestos millboard is used as a sun outside covering on removable boiler insulation.

Figure 6 outlines how to inspect pipe and boiler insulation. Start in the boiler room and follow air and water distribution systems throughout the building. Building plans should indicate the location of pipes and ducts.

If the insulation is in good condition, leave it undisturbed. Sampling is not recommended in this case: instead, assume that the insulation contains asbestos. An EPA nationwide survey of federal, residential, and commercial buildings revealed that approximately 16 percent (20 percent of those constructed before 1970) contained asbestos pipe or boiler insulation. An exception to this rule is yellow or pink wrapped insulation. The color is usually a clear indication of fibrous glass rather than asbestos material. Even here, however, pipe elbows and joints will likely contain asbestos.

Sample the insulation materials from the damaged or exposed ends or other parts. Procedures for sampling and analyzing insulation materials are similar to those for surfacing materials:

- Identify homogeneous areas (i.e., sections of insulation that appear uniform in color and texture).
- Take samples for each homogeneous area where the insulation is damaged or exposed. Remember, all persons taking samples should wear a respirator.
- Submit samples to a qualified laboratory for analysis (see Appendix G).

As indicated in Figure 6, the presence (assumed or confirmed) or absence (confirmed) of asbestos should be documented in permanent records. If asbestos is present, an asbestos control program should be implemented as described in Chapters 3 and 4. If the presence of asbestos has been assumed, sampling and analysis may be useful for confirmation before any additional corrective action is taken.

2.2.4 Procedures for Other ACM

Most ACM in this category (e.g., wallboard, ceiling tile, floor tile) is hard and nonfriable, and sampling would damage it and release fibers needlessly. Information on asbestos in these materials comes mainly from building records or building personnel. Document the presence and location of these materials in permanent records, and proceed with an asbestos control program as described in Chapter 3.

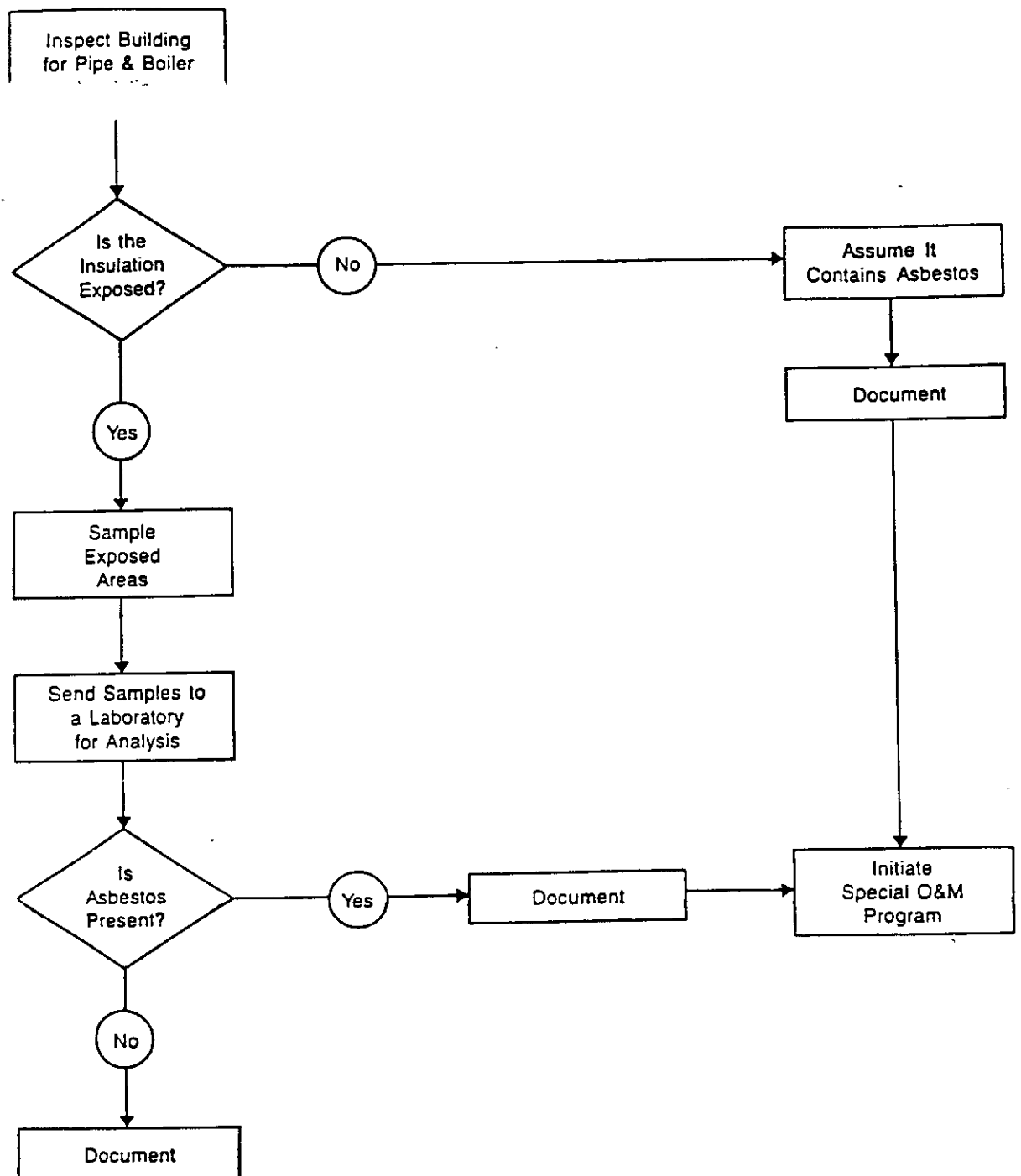


Figure 6. Survey procedures for pipe and boiler insulation.

If ACM is found in a building, a special O&M program should be implemented as soon as possible. An O&M program is recommended for each type of ACM: surfacing material, pipe and boiler insulation, and miscellaneous materials. Although many of the procedures are the same, certain steps vary according to the type of ACM.

SUMMARY

Purpose of a Special O&M Program: The program is designed to (1) clean up asbestos fibers previously released, (2) prevent future release by minimizing ACM disturbance or damage, and (3) monitor the condition of ACM. The program should continue until all ACM is removed or the building is demolished.

Who Should Participate: The asbestos program manager, the manager of building maintenance, and the supervisor of the custodial staff are key participants in the O&M program.

Program Elements: The program should alert workers and building occupants to the location of ACM, train custodial and maintenance personnel in proper cleaning and maintenance, implement initial and periodic cleaning using special methods (for surfacing materials and pipe and boiler insulation only), establish a process that assures ACM is not disturbed during building repairs and renovations, and periodically re-inspect areas with ACM.

3.1 The Purpose of a Special O&M Program

The discovery of ACM in buildings raises two concerns: (1) how to clean up asbestos fibers previously released, and (2) how to avoid ACM disturbance or damage. The special O&M program addresses both of these issues, with procedures tailored to each of the three types of ACM.

3.2 Who Should Participate

The asbestos program manager develops and implements the special O&M program. He or she may serve as coordinator or delegate that responsibility to the facilities manager or other appropriate employee.

The manager of building maintenance and the custodial staff supervisor are the other key participants. Both must support the program and must generate the same sense of commitment in their staff. A special O&M program will increase cleaning and maintenance work; staff dedication is necessary for an effective program.

Trained building inspectors also participate in all special O&M programs. These inspectors may be the ones who made the initial inspection for ACM. They may or may not be members of the in-house custodial or maintenance staff. In the O&M program, they will be inspecting the condition and other characteristics of the ACM as described in Section 4.1.

3.3 Program Elements

Several aspects of a special O&M program are the same for all three types of ACM. For clarity and completeness, these steps are repeated in the description of each program.

ACM that is sprayed or troweled on ceilings and walls is often the main source of airborne asbestos fibers in the building. Areas covered by ACM tend to be large. If the material is friable, fibers are slowly released as the material ages.

To reduce the level of released fibers and to guard against disturbing or damaging the ACM, the following measures should be taken:

Documentation, Education, and Training

The O&M program coordinator should:

- Record the exact location of ACM on building documents (plans, specifications, and drawings).
- Inform all building occupants and maintenance and custodial workers about the location of ACM and caution them against disturbing or damaging the ACM (e.g., by hanging plants or mobiles from the ceiling, or pushing furniture against walls). Be sure to give this information to new occupants and employees.
- Require all maintenance and custodial personnel to wear a half-face respirator with disposable cartridge filters or a more substantial respirator (see Section 5.1) during the initial cleaning and whenever they come in contact with ACM.
- Train custodial workers to clean properly and maintenance workers to handle ACM safely. (As noted in Chapter 2, EPA is sponsoring three pilot training programs. Contact the RAC for information on these and other training programs.)

Initial Cleaning

Custodial staff should:

- Steam-clean all carpets throughout the building or vacuum them with a High Efficiency Particulate Air (HEPA)-filtered vacuum cleaner, but never with a conventional vacuum cleaner. Spray vacuum cleaner bags with water before removal and discard in sealed plastic bags according to EPA regulations for removal and disposal of asbestos (see Section 5.1 and USEPA 1985a). Discard vacuum filters in a similar manner.
- HEPA-vacuum all curtains and books. Discard vacuum bags and filters in sealed plastic bags according to EPA regulations for disposal of asbestos waste.
- Mop all noncarpeted floors with wet mops. Wipe all shelves and other horizontal surfaces with damp cloths. Use a mist spray bottle to keep cloths damp. Discard cloths and mopheads in sealed plastic bags according to EPA regulations for disposal of asbestos waste.

Monthly Cleaning

Custodial staff should:

- Spray with water any debris found near surfacing ACM and place the debris in plastic bags using a dust pan. Rinse the pan with water in a utility sink. Report presence of debris immediately to the O&M program coordinator.

- Wet-mop all other floors and wipe all other horizontal surfaces with damp cloths.
- Dispose of all debris, filters, mopheads, and cloths in plastic bags according to EPA regulations for disposal of asbestos waste.

Building Maintenance

The special O&M program coordinator should:

- Ensure that recommended procedures and safety precautions will be followed before authorizing construction and maintenance work involving surfacing ACM (see Section 5.1). Specifically, containment barriers should be erected around the work area and workers should wear coveralls as well as respirators.

Maintenance staff should:

- Clear all construction, renovation, maintenance, or equipment repair work with the O&M program coordinator in advance.
- Avoid patching or repairing any damaged surfacing ACM until the ACM has been assessed by the asbestos program manager.
- Mist filters in a central air ventilation system with water from a spray bottle as the filters are removed. Place the filters in plastic bags and dispose of them according to EPA regulations.

Periodic Inspection

Building inspectors should:

- Inspect all ACM materials for damage or deterioration at least twice a year and report findings to the O&M program coordinator. (See Chapter 4 for detailed information on assessing ACM.)
- Investigate the source of debris found by the custodial staff.

Custodial and maintenance staff should:

- Inform the O&M program coordinator when damage to ACM is observed or when debris is cleaned up.

An illustrated EPA pamphlet, "Asbestos in Buildings—Guidance for Service and Maintenance Personnel" (USEPA 1985a), may be especially useful in publicizing and initiating the special O&M program. Contact the RAC or call the EPA toll-free line for copies of the pamphlet (see Appendix E for telephone numbers).

The special O&M program should continue until all surfacing ACM is removed. Over time, the special O&M program may need to be altered if the ACM is enclosed or encapsulated (refer to Section 5.1).

3.3.2 Special Practices for Pipe and Boiler Insulation

Asbestos-containing pipe and boiler insulation typically is a less significant source of airborne asbestos fibers than surfacing ACM. Unless damaged, protective jackets around such insulation prevent fiber release.

inspecting the protective jacket (and pipe joints or elbows) for damage, and taking precautions prior to building construction activities. The program also includes repair and selected special cleaning practices.

Documentation, Education, and Training

The O&M program coordinator should:

- Record the exact location of asbestos-containing insulation on building documents (plans, specifications, and drawings).
- Inform maintenance and custodial workers about the location of asbestos-containing insulation, and caution them about disturbing it.
- Post signs reading, "Caution — Asbestos," on boilers, tanks, pipes, and ducts with asbestos-containing insulation.
- Require all maintenance and custodial personnel to wear at least a half-face respirator with disposable HEPA cartridge filters (see Section 5.1) during initial cleaning and whenever they come in contact with asbestos-containing insulation.
- Train custodial workers to clean properly and maintenance workers to handle ACM safely. (As noted in Chapter 2, EPA is sponsoring three pilot training programs. Contact the RAC for more information on these and other programs.)

Initial Cleaning

Custodial staff should:

- Clean carpets in rooms containing heating, cooling, air-handling, and similar equipment that has asbestos-containing insulation. Use a HEPA-filtered vacuum cleaner or steam cleaner. Discard filters in sealed plastic bags according to EPA regulations for removal and disposal of asbestos.
- Wet-mop all other floors in rooms with asbestos-containing insulation. Wipe all shelves and other horizontal surfaces with damp cloths. Use a mist spray bottle to keep cloths damp. Discard cloths and mopheads in sealed plastic bags according to EPA regulations for removal and disposal of asbestos.
- HEPA-vacuum all curtains in rooms with asbestos-containing insulation, and discard vacuum filters in sealed plastic bags according to EPA regulations for removal and disposal of asbestos.

Semiannual Cleaning

Custodial staff should:

- Spray with water any debris found near asbestos-containing insulation, and place the debris in a plastic bag using a dustpan. Clean the pan with water in a utility sink. Report presence of debris immediately to the O&M program coordinator.
- HEPA-vacuum all carpets in rooms with asbestos-containing insulation.

- Wet-mop all other floors and dust all other horizontal surfaces with damp cloths in rooms with
- Seal all debris, vacuum bags, vacuum filters, cloths, and mopheads in plastic bags for disposal according to EPA regulations for asbestos waste.

Maintenance

The special O&M program coordinator should:

- Ensure that recommended procedures and safety precautions will be followed before authorizing construction and maintenance work involving pipe and boiler insulation (see Section 5.2). Specifically, containment barriers or bags should be positioned around the work area and workers should wear coveralls and respirators. Insulation damaged during construction and maintenance activities should be repaired with non-asbestos mastic, new protective jackets, and/or replacement insulation.
- Authorize repair of minor insulation damage with non-asbestos mastic, new protective jackets, and/or non-asbestos insulation following recommended repair techniques and precautions (see Section 5.2).
- Authorize large-scale abatement only after a complete assessment of the asbestos-containing insulation (see Section 5.2).

The maintenance staff should:

- Clear all construction, renovation, maintenance, or equipment repair work with the O&M program coordinator in advance.
- Avoid patching and repair work on insulation until the ACM has been assessed by the asbestos program manager.

Periodic Inspection

Building inspectors should:

- Inspect all insulation for damage or deterioration at least twice a year and report findings to the O&M program coordinator. (See Chapter 4 for detailed information on assessing ACM.)
- Investigate the source of debris found by the custodial staff.

Custodial and maintenance staff should:

- Inform the O&M program coordinator when damage to the insulation is observed or when debris is cleaned up.

The illustrated EPA pamphlet, "Asbestos in Buildings—Guidance for Service and Maintenance Personnel" (USEPA 1985a), may be useful for the special O&M program for pipe and boiler insulation. The O&M program should continue until all asbestos-containing insulation (including materials on pipe joints and elbows) is removed and replaced with another type of insulation.

3.3.3 Special Practices for Other ACM

Most ACM that is neither surfacing material nor pipe and boiler insulation is hard and nonfriable. This type of ACM releases fibers only when manipulated (e.g., cut, drilled, sawed) or damaged. The special O&M program is designed to alert workers to the location of ACM, and to avoid its disturbance or damage.

Documentation, Education, and Training

The O&M program coordinator should:

- Record the exact location of these types of ACM on building documents (plans, specifications, and drawings).
- Inform maintenance and custodial workers about the location of ACM and caution them about disturbance or damage.
- Train maintenance workers to handle ACM safely. (As noted in Chapter 2, EPA is sponsoring three pilot training programs. Contact the RAC for information on these and other programs.)

Maintenance

The O&M program coordinator should:

- Ensure that recommended procedures and safety precautions will be followed before authorizing construction or maintenance work involving ACM. Specifically, containment barriers should be erected around the construction and maintenance work area and workers should wear coveralls as well as respirators. All tools should be equipped with HEPA-filtered vacuum devices.

The maintenance staff should:

- Clear all construction, renovation, maintenance, or equipment repair work with the O&M program coordinator in advance.
- Avoid removing, sanding, or stripping floor tiles containing asbestos. If tiles are removed, do not sand asbestos backing material remaining on the floor.

Periodic Inspection

Building inspectors should:

- Inspect all ACM for damage or deterioration at least twice a year, and report findings to the O&M program coordinator.

Custodial and maintenance staff should:

- Report any ACM damage to the O&M program coordinator.

The special O&M program for miscellaneous ACM should continue until all ACM is removed.

If a building contains ACM, implementing a special O&M program will remove asbestos fibers and limit further fiber release. Once the program is operational, the need for additional asbestos control or abatement should be considered. Three questions need to be answered:

- Is abatement necessary?
- When should abatement be done?
- What abatement method should be used?

In some situations, assessing the need for abatement is a straightforward process. Badly damaged ACM in public areas should be removed immediately. ACM in good condition with virtually no chance of being disturbed except under controlled conditions (e.g., during scheduled repairs) requires no additional action, at least not immediately. (An example of the latter is tightly bound, undamaged ACM insulation wrapped around heating or water pipes.) Deciding how to control ACM is complicated; assessment requires simultaneous consideration of the type and condition of the material, timing and alternative abatement methods, as well as constraints that are specific to individual buildings.

This chapter contains an approach to assessing the need for abatement, determining its timing, and choosing an abatement method. Factors used in the decision-making process are introduced and discussed. The three types of ACM — surface material, pipe and boiler insulation and miscellaneous products — are treated separately. Constraints that affect individual owners or buildings are also discussed.

SUMMARY

Assessment Information:

- The likelihood of fiber release from ACM is based on evaluating its current condition and the potential for future disturbance, damage, or erosion.
- Air monitoring alone should not be used for assessment.

The Assessment Process:

The likelihood of fiber release from ACM determines the need for and timing of additional action. The nature and location of the material determines the abatement method.

• Surfacing Materials

Need: Surfacing material in good condition and with a low potential for future disturbance, damage, or erosion may need no further action.

Timing: ACM in poor condition should be dealt with first. If ACM is in good condition but has a high potential for future fiber release, abatement can be scheduled with building renovation or maintenance.

Method: Removing the ACM is the only permanent solution. Enclosure and encapsulation are temporary solutions to be implemented in special circumstances.

Need: If the insulation is intact, no further action is needed.

Timing: Damaged insulation should be repaired or replaced as soon as possible.

Method: Removal is appropriate where the insulation is extensively damaged or deteriorated.
Repair is appropriate where the insulation has minor damage.

- **Other Types of ACM**

A special O&M program is usually all that is needed.

Further Considerations in Selecting an Abatement Schedule:

- If an abatement project is not urgent, it will be less costly if combined with building repair, renovation, or expansion, or with scheduled maintenance to equipment and building systems.
- Other factors that may influence the timing of abatement include:
 - The pattern of normal building operations;
 - The building owner's legal liability;
 - Pressures from building occupants and the public; and
 - Expected useful life of the building.

4.1 Assessment Information

The need for asbestos control beyond a special O&M program depends on the likelihood of fiber release from ACM. The possibility of fiber release should be assessed by evaluating the material's condition, physical characteristics, and location. Another approach is to measure the current levels of asbestos in the air. As explained below, however, assessment by air monitoring alone is not recommended because it reflects conditions only at the time of sampling. In addition, air monitoring is technically difficult and expensive.

4.1.1 Potential Fiber Release

Factors for assessing fiber release potential are listed in Table 1. (Figures 7 and 8 illustrate some of these factors.) The first set of factors focuses on the current condition of ACM. If water or physical damage, deterioration, or delamination of the material is evident, then fiber release has occurred, is occurring, or is likely to occur. The appearance of the material and the presence of broken or crumbled material on horizontal surfaces indicate fiber release.

Factors under the second heading in Table 1 reflect potential fiber release due to disturbance or erosion. Visible, highly accessible materials in areas frequently used or needing periodic maintenance are most vulnerable to physical damage. Also in this category are materials subject to vibration from mechanical equipment, sound, or athletic activities — for example, materials near a gymnasium or band room, or in buildings near an airport or highway. ACM in an air plenum or near a forced airstream (e.g., air from a heating vent) is likely to suffer surface erosion. In addition, fibers released into an airstream may be transported to other parts of the building, possibly exposing more people. Any planned changes in building use should also be considered when assessing potential fiber release.

Table 1. Factors for Assessing Potential Fiber Release

Current Condition of ACM

- Evidence of deterioration or delamination from the underlying surface (substrate)
- Evidence of physical damage (e.g., presence of debris)
- Evidence of water damage

Potential for Future Disturbance, Damage, or Erosion of ACM

- Proximity to air plenum or direct airstream
 - Visibility, accessibility (to building occupants and maintenance personnel), and degree of activity (air movement, vibration, movement of building occupants)
 - Change in building use
-

The factors in Table 1 are fully described in Appendix H. The descriptions should assist the evaluator in assessing ACM at individual sites.

A simple "present" or "absent," "high" or "low" rating should be used for each factor. More elaborate rating schemes have been tried. For example, factors have been assigned numerical scores and, using mathematical formulas, the scores have been combined into indices to reflect potential exposure.¹ These "exposure indices" have met with mixed success. In tests, several indices showed wide variation from one rater to the next and often did not indicate current, elevated airborne asbestos levels (e.g., USEPA 1983b). Assigning numerical ratings to assessment factors and combining them into a single score cannot be recommended. However, the factors are useful when they are scored with a simple, nonnumerical rating scheme.

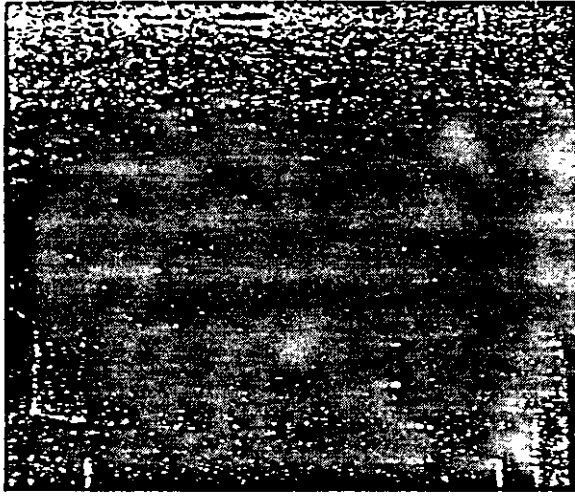
4.1.2 Air Monitoring

Another way to assess asbestos fiber release is to measure asbestos fibers in the air. This approach is appealing because it quantitatively measures airborne asbestos contamination. However, it measures only current conditions and provides no information about fiber release potential and future air levels. Moreover, implementing an effective monitoring program to measure current levels of airborne asbestos is difficult and can be expensive.

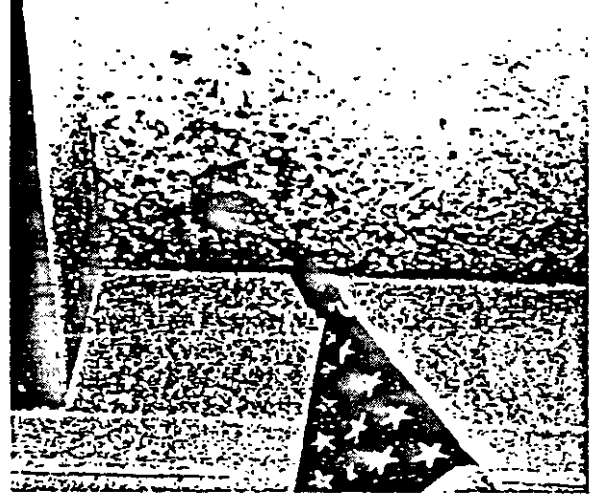
One proposed method for measuring airborne asbestos in buildings was developed by the National Institute for Occupational Safety and Health (NIOSH) in connection with the OSHA asbestos exposure standard for workplace settings. This method uses phase contrast microscopy (PCM), which may be effective for industrial measurements where most airborne fibers are asbestos, but is less useful in settings with much lower asbestos levels. PCM is not sensitive to fibers with diameters less than 0.2 micrometers.² In addition, the NIOSH method excludes fibers shorter than 5 micrometers and does not distinguish between

¹ See, for example, Lory 1980, Pinchin 1982, and USEPA 1979.

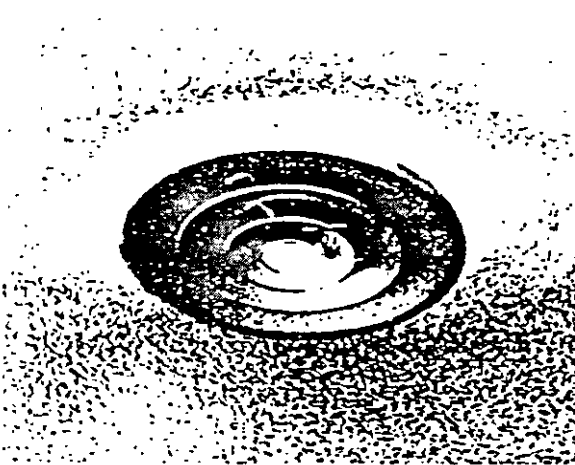
² A micrometer is one-millionth of a meter. See Appendix B for a simple discussion of measurement units used to describe and measure asbestos fibers.



Water damage



Physical damage to ceiling material from a flagpole

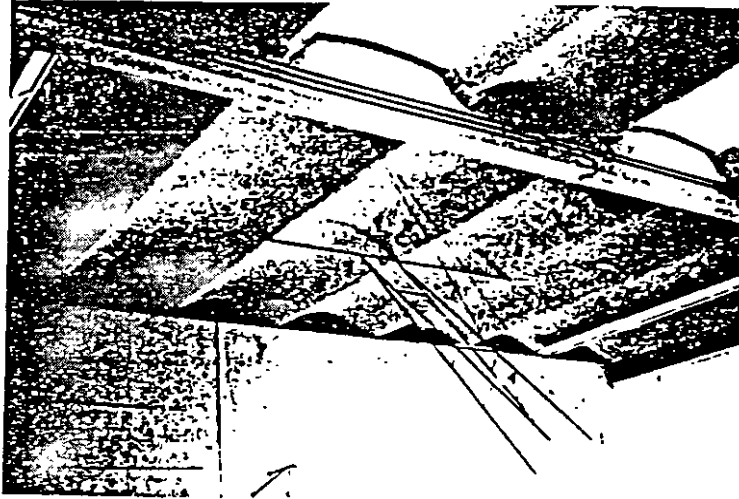


Airstream erosion from a heating vent

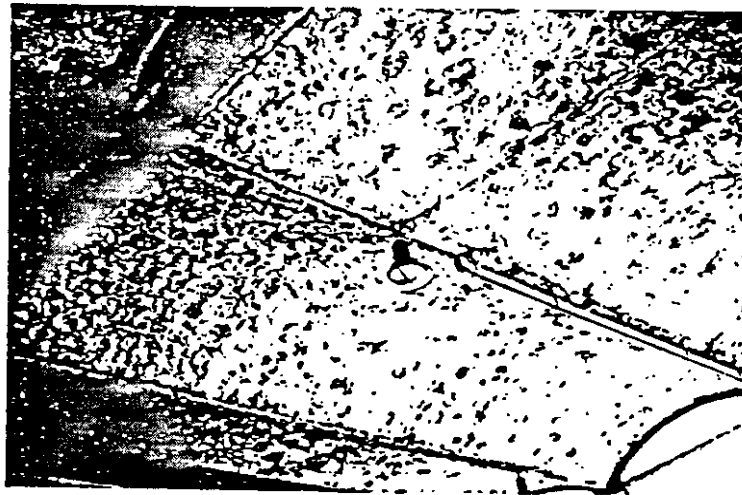


High activity level near friable asbestos

Figure 7. Example assessment characteristics of asbestos-containing materials.



Ceiling of a gymnasium in an elementary school
(no basketball marks)



Ceiling of a gymnasium in a high school showing evidence of
damage from basketballs thrown by students

Figure 8. An example of the effect of a change in building use.

shorter than these limits (Chatfield 1983 and NRC 1984), and are likely to include fibers from carpets, clothing, hair, paper, books, and many other sources. As a result, PCM analyses of air inside these buildings could be seriously misleading.

Other methods measure both small and large fibers and distinguish asbestos from non-asbestos materials. Those methods count fibers by electron microscopy, and confirm that the fibers are asbestos with chemical and crystallographic analyses. The analytical transmission electron microscope (TEM)³ is the most sensitive and asbestos-specific instrument. EPA has used TEM in experiments to establish baseline asbestos levels indoors and outdoors. However, obtaining enough samples to estimate prevalent airborne levels is difficult in occupied buildings. In addition, TEM analysis is expensive (ranging from \$200 to \$600 per sample) and few laboratories are qualified to perform it. These limitations, combined with the inability of air monitoring to provide information on future conditions, restrict its usefulness for assessment. EPA, therefore, does not recommend it as a primary assessment tool at this time. (Air monitoring does have a role, however, in determining when an abatement project is complete. See Section 6.4.)

4.2 The Assessment Process

The assessment factors discussed above are used to decide if additional asbestos control is needed and, if so, when and what method. Although the process is similar for each of the three types of ACM, the details are specific to each type and are discussed separately below.

4.2.1 Sprayed- and Troweled-on Surfacing Materials

4.2.1.1 Need

Use the factors described in 4.1.1 to determine the current condition of the ACM and the potential for future disturbance, damage, or erosion. Table 2 shows how these two considerations influence the decision regarding action beyond a special O&M program. Surfacing material in good condition may need no further action if potential for future disturbance, damage, or erosion is low. The material must be inspected regularly (see Section 3.3.1) to assure that it remains in good condition. Further action is needed if the material is damaged or in poor condition, or if there is high potential for future disturbance or erosion.

4.2.1.2 Timing

When further action is necessary, its timing must be carefully considered. A well-planned and executed abatement program is needed to ensure that the abatement activity itself does not create a hazard. If the ACM is currently in good condition, but the potential for future fiber release is high, scheduling of asbestos abatement can take advantage of other building plans. For example, renovation work, which requires precautions to control fiber release, provides an opportunity to remove, encapsulate, or enclose ACM. There are no set rules to determine the timing of asbestos abatement, since circumstances vary from building to building. Table 2 provides a guide.

As one moves through the table from left to right (from good to poor condition) and from top to bottom (from low to high potential for disturbance, damage, or erosion), the need for immediate action increases. Material in poor condition should be dealt with first. Materials that are in better condition or have a low potential for disturbance or erosion have a lower priority.

³ A provisional method for TEM measurement of asbestos has been developed by EPA (USEPA 1977).

Table 2. Assessment Table for Surfacing Materials

Potential for Future Damage, Disturbance, or Erosion	Current Condition of ACM		
	Good*	Minor Damage or Deterioration	Poor
Low	No Further Action Now Beyond Special O&M Program	Selective or Complete Removal as Soon as Possible	Removal as Soon as Possible
High†	Removal, Enclosure, Encapsulation Integrated with Other Building Activities		

*Good condition means no water damage, physical damage, or deterioration.

†High potential means that ACM is exposed or accessible, in an air plenum or airstream, or subject to vibration.

Table 3. Comparison of Asbestos Abatement Methods for Surfacing Materials

Method	Advantages	Disadvantages	Appropriate applications	Inappropriate applications	General comments
Removal	<p>Eliminates asbestos source</p> <p>Eliminates need for special operations and maintenance program</p>	<p>Replacement with substitute material may be necessary</p> <p>Porous surfaces also may require encapsulation</p> <p>Improper removal may raise fiber levels</p>	<p>Can be used in most situations</p>		<p>Containment barriers needed</p> <p>Worker protection required</p> <p>Wet removal is required for all types of asbestos. (amosite will not absorb water or water with traditional wetting agents)</p> <p>Disposal may be a problem in some areas</p> <p>Unusual circumstances, complex surfaces, and the presence of utilities may require special removal techniques</p>
Enclosure	<p>Reduces exposure in area outside enclosure</p> <p>Initial costs may be lower than for removal unless utilities need relocating or major changes</p> <p>Usually does not require replacement of material</p>	<p>Asbestos source remains and must be removed eventually</p> <p>Fiber release continues behind enclosure</p> <p>Special operations program required to control access to enclosure for maintenance and renovation</p> <p>Periodic reinspection required to check for damage</p> <p>Repair of damaged enclosure necessary</p> <p>Fibers released in dry form during construction of enclosure</p> <p>Long-term costs could be higher than for removal</p>	<p>ACM is located in a small area (e.g., a column)</p> <p>Disturbance or entry into enclosed area unlikely</p>	<p>Damaged or deteriorating materials causing rapid fiber release</p> <p>Water damage evident</p> <p>Damage or entry into enclosure likely</p> <p>Ceiling to be enclosed is low</p>	<p>Containment barriers needed</p> <p>Use of tools with HEPA-filtered vacuum attachments advisable</p> <p>Worker protection needed</p>

Table 3. (continued)

Method	Advantages	Disadvantages	Appropriate applications	Inappropriate applications	General comments
Encapsulation	Reduces asbestos fiber release from material	Asbestos source remains and must be removed later	Material still retains bonding integrity	Material does not adhere well to substrate	Containment barriers needed
	Initial costs may be lower than for removal	If material is not in good condition, sealant may cause material to delaminate	Damage to material not likely	Material is deteriorating or damaged, or damage is likely	Worker protection need
	Does not require replacement of material	Periodic reinspection required to check for damage or deterioration	Material not highly accessible	Water damage is evident	Airtight sprayers should be used
		Repair of damaged or deteriorating encapsulated surface required	Material granular, cementitious	Material is fibrous, fluffy	Previously encapsulated materials may have to be re-encapsulated
		Encapsulated surface is difficult to remove and may require dry techniques for eventual removal	After removal of ACM, if the substrate is porous		
		Long-term costs may be higher than removal			